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**SynApps:**

Children's ASD Management Through A Mobile  
Application and An Interactive Biofeedback Exercise

By Elizabeth Richardson

A Thesis Submitted in Partial Fulfillment of the requirements for  
the degree of Master of Fine Arts in Visual Communication Design

Rochester Institute of Technology  
College of Imaging Arts and Sciences  
School of Design  
MFA Visual Communication Design  
May 2017

## **SynApps**

Children's ASD Management Through A Mobile Application and An Interactive Biofeedback Exercise

Submitted by Elizabeth Richardson

Date May 2017

### **Thesis Committee Approval**

#### **Chief Thesis Adviser**

Dan DeLuna, Associate Professor

College of Imaging Arts and Sciences, Visual Communication Design

---

Signature of Chief Thesis Adviser

---

Date

#### **Associate Thesis Adviser**

Chris Jackson, Professor

College of Imaging Arts and Sciences, Visual Communication Design

---

Signature of Associate Thesis Adviser

---

Date

#### **Associate Thesis Adviser**

Laurence I. Sugarman, Research Professor & Director

Center for Applied Psychophysiology and Self-regulation, College of Health and Sciences

---

Signature of Associate Thesis Adviser

---

Date

#### **Administrative Chair, School of Design**

Peter Byrne

College of Imaging Arts and Sciences

---

Signature of Administrative Chair, School of Design

---

Date

#### **MFA Thesis Candidate**

Elizabeth Richardson

Visual Communication Design, College of Imaging Arts and Sciences

---

Signature of MFA Thesis Candidate

---

Date

## **Dedication**

This thesis is dedicated to Kathy Richardson, Dennis Richardson, David Richardson, Katie Orem, Evan Orem and Ben Hamlin. For their unending love, encouragement and support.



## **Acknowledgments**

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Daniel DeLuna  
Chris Jackson  
Dr. Laurence Sugarman  
Rochester Institute of Technology

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A.1 Thesis Proposal

## Abstract

This thesis explores how to provide better access to alternative treatment options through an immersive biofeedback exercise and mobile application for children with autism spectrum disorders (ASD). This thesis also seeks to connect children with ASD to medical professionals and treatment facilities.

This is done through a motion graphics piece depicting an abdominal breathing exercise and correlating mobile application. Users participate in biofeedback exercises in which their real-time biofeedback is monitored, transmitted to the mobile application, and reflected to the user. The mobile application analyzes and identifies physiological signals and detects what feedback is most useful to help the individual meet goals of increased vagal tones. Increased vagal tones correlates with high frequency heart rate variability.<sup>1</sup> The game promotes self-awareness and self-regulation through abdominal breathing, heart rate variability, and mindfulness.

If done consistently, biofeedback exercises may help re-train the body's response to stressful situations, leading to function and behavioral improvements in everyday life. Additionally, this treatment application aims to be a preventative health option for children with ASD as a means to hopefully diminish the lifetime costs of care.

This topic is important to the field of design and the broader community because it utilizes the power of design, motion, and interactive technology to potentially bring about improvements to the lives of children with ASD. Furthermore, this thesis unifies design with science as a means to bring better health care access and support services to people with ASD.

## Keywords

Autism, ASD, Biofeedback, Mobile Application, UX

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<sup>1</sup> Daniel M. Hicks, Eric T. Hunt, Lindsay M. Alvut, Anna E. Hope, and Laurence I. Sugarman. Center for Applied Psychophysiology and Self-Regulation. Improving the Graphical User Interface (GUI) for the Dynamic Feedback Signal Set (DyFSS): Increasing Accessibility for the Neurodiverse. Accessed May 17, 2017.

## Situation Analysis

Autism spectrum disorder (ASD) is a term used to define a complicated disorder of brain development.<sup>2</sup> The U.S. Centers for Disease Control and Prevention claims that ASD affects around 1 in 68 American children, or more than 3.5 million Americans.<sup>2</sup> Recently, government ASD statistics show that diagnoses have risen from ten to seventeen percent. People with ASD experience varying degrees of difficulties with both verbal and non-verbal communication, social interaction, language, and repetitive behaviors.<sup>2</sup> As a result, people with ASD may isolate themselves, not react or become seemingly indifferent to social interactions, and have trouble communicating. These symptoms have been posited to be related to impaired autonomic self-regulation.

The cost in the United States for a person with ASD, with an intellectual disability, over a lifespan is \$2.4 million on top of the average of \$250,000 to raise a child without ASD.<sup>3</sup> Ostrow suggests that most of these costs occur in adulthood due to loss of employment, impaired ability to maintain a job, the need for medication and special education, and in some cases residential care. Ostrow continues by adding that, many adults with ASD cannot monetarily contribute toward the maintenance of their disorder because they either: did not graduate from school and cannot get a job, or cannot maintain a job. Early diagnosis followed by intervention can cut the lifelong costs of ASD by two-thirds.<sup>3</sup> This early intervention can possibly begin with consistent biofeedback treatments.

Research has proven that sensory rooms help children with ASD to calm down when feeling over stimulated. Interactive sensory technology can be found in these rooms including: lights, projections, interactive screens, music, enclosed structures, objects safe to chew on, tactile objects, and comfortable seating.<sup>4</sup>

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2 Autism Speaks. 2016. Accessed September 28, 2016. <https://www.autismspeaks.org/>.

3 Ostrow, Nicole. Bloomberg. June 14, 2014. Accessed October 8, 2016. Autism Costs More Than \$2 Million Over Patient's Life.

4 "History of Multi-Sensory Rooms (MSRs)." Accessed October 4, 2016. [http://www.special-haven.org/History\\_of\\_Multi-Sensory.html](http://www.special-haven.org/History_of_Multi-Sensory.html).

Additionally, some research supports a positive correlation between biofeedback exercises, enhanced self-awareness and autonomic regulation.<sup>1</sup> Studies cited by Sugarman, Garrison, and Williford suggest that a combination of biofeedback and hypnosis therapy can be therapeutic for people with ASD.<sup>5</sup> However, there are limitations to current biofeedback therapy. The implementation of biofeedback exercises can be limited to a small monitor with inconsistent visual styles and varying design systems.

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5                      Sugarman, Laurence I., Brian L. Garrison, and Kelsey L. Williford. 2013. "Symptoms as Solutions: Hypnosis and Biofeedback for Autonomic Regulation in Autism Spectrum Disorders." *American Journal of Clinical Hypnosis* 56 (2): 152-73. <http://search.proquest.com.ezproxy.rit.edu/docview/1562028291?accountid=108>.

## Problem Statement

**Can an immersive biofeedback exercise and corresponding mobile application be an effective means for people with ASD to receive biofeedback therapy?**

This thesis aims to create improved access to experiential treatment possibilities and alternative therapy options for children with ASD. This will be done through a one-minute motion graphics piece depicting a biofeedback exercise in session, and a non-working mobile application. The non-working mobile application connects the user to the biofeedback exercise. The mobile application can be used to save and review users' biofeedback exercise history, progress and medical information. The biofeedback mobile application and exercise will target increased vagal tone and autonomic regulation through synchronizing abdominal breathing with heart rate.

The motion graphics piece will simulate how users interact with the biofeedback exercise system. A feedback loop is created and conditions physiological control in addition to helping users evolve that control. This is a recursive process that aims to condition users.

The biofeedback exercise will be created in a game format, with an integrated reward system as a means to fully engage and intrigue the user. This application enables users to participate in the exercise and receive real-time biofeedback, with the intent to re-train the body's response to stress and anxiety for a person with ASD.

This thesis seeks to provide access to an experiential treatment option with the oversight of a medical professional. This thesis aims to be utilized in a medical or behavioral professional's office. Through this system, children with ASD will access to an immersive therapy option.

## Survey of Literature

### **ASTEP - Asperger Syndrome Training & Employment Partnership**

Accessed: October 5, 2016

<http://asperger-employment.org>

ASTEP promotes the inclusion of people with ASD in employment by educating employers and building relationships between employers and professional support organizations. ASTEP also does this through trainings with Fortune 1000 companies that help employers understand and build support programs for employees with ASD.

### **Autism Classification System of Functioning: Social Communication (ACSF: SC)**

**Can Child**

Accessed: October 7, 2016

<https://canchild.ca/en/resources/254-autism-classification-system-of-functioning-social-communication-acsf-sc>

CanChild is a research center. CanChild discusses the ways in which they diagnose social skill levels for children with ASD. This is based off of a five-level system. It is used by medical and behavioral professionals as well as teachers and parents to discuss a child's levels of ability and social skills.

### **Autism Costs More Than \$2 Million Over Patient's Life**

Nicole Ostrow

June 14, 2014

<http://www.bloomberg.com/news/articles/2014-06-09/autism-costs-more-than-2-million-over-patient-s-life>

Accessed: October 8, 2016

Ostrow explains research findings that the lifelong cost to care for a person with ASD, with an intellectual disability, can be more than 2 million dollars. This is additional to the 250,000 dollars it costs to raise a child. Special education, lack of employment, and residential care can be leading causes for these costs in adulthood. In the US, more than 3.5 million people have ASD. The US national cost of supporting children with ASD is 61 to 66 billion dollars each year, versus 175 to 196 billion dollars to support adults.



### **Autism Speaks**

Accessed: September 28, 2016

<https://www.autismspeaks.org/>

Autism Speaks is an educational organization that serves to raise awareness about and support for people with ASD. Autism Speaks is also actively supportive in ASD research in creating better solutions for ASD management.

### **A Portable Sonified Neurofeedback Therapy for Autism Spectrum Disorder Patients-An Initial Evaluation**

Adrian Attard Tevisan, Paolo Cavallari, and Frederick Attard

Accessed: September 30, 2016

Doi: 10.4172/2329-6895.1000133

This research documents therapy done through a sonified neurofeedback system for children with ASD. The research studied neurofeedback from an EEG brain-to-music system can suppress Delta waves while promoting Beta and Alpha waves. The Brain Music System turned recorded EEG information into signals for users. The study showed that kids with ASD were able to manage symptoms of ASD and even improved in doing so.

### **Biofeedback as an alternative treatment for Autism Spectrum Disorder with Asian Americans**

Sum Yin Ruth Wong

2015

Alliant International University

Accessed November 1, 2016

<http://search.proquest.com.ezproxy.rit.edu/docview/1733680870?accountid=108>.

Wong discusses how the medical field faces obstacles in considering and including cultural factors when developing treatments for people with ASD. Wong suggests that current methods are not as effective for Asian Americans. This includes language differences and stigmas amongst Asian Americans around psychotherapies. Wong explores biofeedback as a treatment possibility since it already has a history of effectively helping treat symptoms of ASD.

**Brain-Computer Interface Game Applications for Combined Neurofeedback and Biofeedback Treatment for Children on the Autism Spectrum**

Elisabeth V.C. Friedrich, Neil Suttie, Aparajithan Sivanathan, Theodore Lim, Sandy Louchart, and Jaime A. Pineda

July 3, 2014

Frontiers in Neuroengineering

Accessed: October 4, 2016

Doi: 10.3389/fneng.2014.00021

This study suggests problems in the mirror neuron system are the cause of ASD. It also suggests that biofeedback is just as important as neurofeedback. The study looks at: how social interactions effect heart rate and how a combined approach of neuro and biofeedback is the most effective method of treating symptoms of ASD. Currently, a combined brain-computer interface that combines neuro and biofeedback does not exist. As a result, the study creates a game that considers neuro and biofeedback in a social format.

**Breaking into the Autistic Brain**

Parizad Bilimoria

Boston Children's Hospital

Accessed September 28, 2016

<http://www.childrenshospital.org/news-and-events/research-and-innovation-features/breaking-into-the-autistic-brain>

Parizad gives an overview of what ASD is, what happens in the person's brain and the problems that occurs in the absence of MeCP2, how a child with autism has a disconnected development, his research on mice, and the benefits of EEG technology on people with ASD.

**Characteristics of Resonance in Heart Rate Variability Stimulated by Biofeedback**

Evgeny G. Vaschillo, Bronya Vaschillo, and Paul M. Lehrer

June 2006

Springer Science & Business Media

Accessed: November 5, 2016

Doi: 10.1007/s10484-006-9009-3

The authors of this paper have previously found that heart rate biofeedback helps in treating asthma patients. This study serves as an important research example of how biofeedback, particularly heart rate variability, can help with symptoms of ASD

**Colors of Autism Spectrum Described by Researchers**

May 18, 2016

Science Daily

[www.sciencedaily.com/releases/2016/05/160518120521.htm](http://www.sciencedaily.com/releases/2016/05/160518120521.htm)

This article discusses the creation of the ACSF:SC system, which can be used to classify and diagnose levels of autism. Levels of social interactions and communication are the backbone of this study. The system can be used by medical and behavioral professionals to diagnose levels of ASD. It focuses on what can the person do versus what they cannot do. This is an important factor when considering how to develop engaging and inclusive systems of technology for children with ASD.

**Computer-based interventions to improve social and emotional skills in individuals with autism spectrum disorders: A systematic review**

Sathiyaprakash Ramdoss, Wendy Machalicek, Mandy Rispoli, Austin Mulloy, Russell Lang, Mark O'Reilly

April 2012

Developmental Neurorehabilitation

Accessed: November 10, 2016

Doi: 10.3109/17518423.2011.651655

The authors discuss how their objective is to review studies using computer-based interventions (CBI) to improve the effects of ASD on people. The authors focused on the improvement of social and emotional skills through the utilization of: visual learning tools, decreasing opportunities for interruptions, and clearly explained instructions. This study found that CBIs are effective, and just as good as face-to-face guidance. CBIs help people with ASD advance in their emotional and social interactions. When considering medical applications, it is important to consider the possibilities and benefits of customization to a user's specific wants and needs.

**Creating Immersive Experiences Through Experiential Branding and Wayfinding**

Paul Orban and Tim Smith

November 19, 2014

University Business

Accessed: September 15, 2016

<https://www.universitybusiness.com/article/immersive-exp>

Orban and Smith review how institutions and higher education require environments that reflect their culture. A brand combined with effective wayfinding can provide an import way for a person to understand their spatial orientation. Orban details the importance of integrating experiential branding and wayfinding.

**Deep Brain Neurofeedback**

Brain Works

Accessed: October 10, 2016

<http://www.brainworksneurotherapy.com/deep-brain-neurofeedback>

Brain Works discusses their implementation of neurofeedback on people.

They talk about the benefits of neurofeedback for children with ASD as well as people suffering from other cognitive disorders. Their neurofeedback includes QEEG pictures of the brain. Brain Works also utilizes LoRETA imaging, or Low Resolution Electromagnetic Tomography. Through these components combined, Brain Works helps patients train their brain activity to a more efficient state. This is done through 19 sensors and a 3D LoRETA.

**Designing Environments for Children with ASD**

Maria Luigia Assirelli

GA Architects

[www.autism-architects.com](http://www.autism-architects.com)

The architects worked with design research centers, schools, teachers, caregivers, and children ages 15-19 with ASD to select preferred colors for children with autism. Research found: low arousal, single shades, and cooler tones of blue and green were selected as being most effective. Patterns should be avoided. A balance between gray and color treatments was successful. These results are important to consider when thinking about visual style and language for a thesis project.

**Designing for Interaction Immediacy to Enhance Social Skills of Children with Autism**

Monica Tentori, Gillian R. Hayes

September 26, 2010

Association for Computer Machinery

Accessed: September 26, 2016

Doi: 10.3389/fneng.2014.00021

Tentori and Hayes consider the impact social skills and behavioral intervention have on people with ASD. They consider the importance of immediately guiding and directing behavior through positive reinforcement. This is done through research in three public schools. Tentori and Hayes implement interaction immediacy through applications and social interactions.

**Designing Interactive Technologies for Supporting Research in Autism Spectrum Disorders**

David Feil-Seifer, Matt Black, Maja Mataric, and Shrikanth Narayanan

Accessed: October 3, 2016

<http://robotics.usc.edu/publications/media/uploads/pubs/608.pdf>

Researchers found evidence suggesting that people with ASD are more likely to increase social interactions when conversing with a robot versus another person. Furthermore, children with ASD were more likely to initiate social interactions when interacting with a robot. Researchers are currently designing a therapy robot that helps children ASD with social behaviors.

**Development of a parent manual on assessment -guided biofeedback for Autism Spectrum Disorders**

Mirta Romero Frimtzis

March 29, 2009

Alliant International University

Accessed November 2, 2016

<http://search.proquest.com.ezproxy.rit.edu/docview/305162795?accountid=108>.

Frimtzis develops a parent manual to raise awareness of biofeedback therapy as a treatment option for children with ASD. Frimtzis discusses how there is not enough educational materials on biofeedback treatment for children with ASD. Frimtzis' manual on biofeedback was found in user surveys to be helpful,

educational, and had an overall positive response.

**Economic Burden of Childhood Autism Spectrum Disorders**

Tara A. Lavelle, Milton C. Weinstein, Joseph P. Newhouse, Kerim Munir, Karen A. Kuhlthau, Lisa A. Prosser

February 10, 2014

American Academy of Pediatrics

Doi: 10.1542/peds.2013-0763

Researchers use data to estimate the annual costs for a child with ASD. Research found that the monetary burden of ASD is huge not only on families but also on our society. This study further supports the need for early intervention and alternative treatment technology for children with ASD.

**Evaluating the Effectiveness of Biofeedback in Improving Emotional Regulation for a Student with Autism Spectrum Disorder**

Elizabeth Power

October 20, 2015

The Chicago School of Professional Psychology

Accessed: November 1, 2016

<http://search.proquest.com.ezproxy.rit.edu/docview/1778844198?accountid=108>.

Power studies and assess the impact of biofeedback on an eight-year old child with ASD. Power utilizes heart rate variability, in correlation with the child's overall emotional regulation and found that it helped the child establish a stronger emotional foundation and regulation. Heart rate is an important piece of biofeedback to consider as an area of focus for interactive applications.

**Evaluating the Effectiveness of Biofeedback Interactive Technologies for Children with Special Needs**

Meryl Alper, Juan Pablo Hourcade, and Shuli Gilutz

June 2012

Association for Computer Machinery

Accessed: September 25, 2016

Doi: 10.1.1.690.2712&rep=rep1&type=pdf

Alper, Hourcade, and Gilutz discuss current design trends toward new and exciting therapeutic technologies for disabled children. Their research highlights under-explored areas in interactive technologies. One of these areas is participatory design as it relates to social interactions among children with ASD. The authors have a featured section devoted to technologies that help

children with ASD manage social behavior and interactions.

**Introducing and Illustrating Biofeedback to Young People with Autism Spectrum Disorder**

Eric Hunt, Daniel Hicks, Anna E. Hope, Brian L. Garrison, Stephen Jacobs, Laurence I. Sugarman

The Center for Applied Psychophysiology and Self-Regulation at RIT

Accessed: October 26, 2016

<http://scholarworks.rit.edu/cgi/viewcontent.cgi?article=1035&context=eatc>

This diagram represents biofeedback's background, what DYFUSS is and how it works, and improvements to this system.

**Investigating the Autonomic Nervous System Response to Anxiety in Children with Autism Spectrum Disorders**

Azadeh Kushki, Ellen Drumm, Michele Pla Mobarak, Nadia Tanel, Annie Dupuis, Tom Chau, and Evdokia Anagnostou

July 12, 2012

Doi:10.1371/journal.pone.0059730

This study explores how and if anxiety causes changes in indicators of ANS and ASD. It also seeks to understand and convey a pattern in these changes. Areas measured included: skin temperature, heart rate, and electrodermal activity. This was done with two groups of children, one group with ASD, and the other with ASD. Both groups were monitored in a baseline and an anxiety condition. Only the ASD group showed abnormally increased heart rate during both conditions. This study suggests that ASD is linked to over-arousal which can result in people with ASD experiencing abnormal levels of anxiety.

**Jacob's Ladder Center**

<http://jacobs laddercenter.com/methodology/references-and-research/>

Jacob's Ladder is a center serving Pre-K through 12th graders with any neurological disorder, learning disability, or genetic disorder. 60% of their students have been diagnosed with Autism. Jacob's Ladder utilizes neurofeedback as a form of therapy for its patients.

**Long-Term Follow-Up of Self-Hypnosis Training for Recurrent Headaches:**

What the Children Say

Daniel P Kohen

2010

International Journal of Clinical and Experimental Hypnosis

Accessed November 2, 2016

[http://search.proquest.com.ezproxy.rit.edu/  
docview/859366602?accountid=108](http://search.proquest.com.ezproxy.rit.edu/docview/859366602?accountid=108)

Kohen recounts a survey conducted of 178 children who were referred to hypnosis as a treatment for ongoing headaches. The survey covered current status of headaches including: intensity and frequency, treatment, how hypnosis was used, and reviews of self-hypnosis. Overall, survey responses showed that participants positively responded to hypnosis in treating ongoing headaches years following application of hypnosis. Hypnosis is related to breathing, which is also related to heart rate, and is an important element of biofeedback for people with ASD. Thus, hypnosis should be considered when developing new treatment technologies for children with ASD.

**Making Room for Autism in the Workplace**

Elizabeth Preston

July 21, 2016

The Atlantic

Accessed: October 5, 2016

[http://www.theatlantic.com/health/archive/2016/07/making-room-for-autism-  
in-the-workplace/492050/](http://www.theatlantic.com/health/archive/2016/07/making-room-for-autism-in-the-workplace/492050/)

Preston discusses a program that helps train young adults with ASD through virtual job interviewers. Participants learn necessary workplace skills, train for industry certifications, and complete internships. Additionally, users can practice interviewing with an avatar. At the workplace people with ASD may experience anxiety and have trouble communicating with coworkers. Preston discusses how many adults with ASD want to work and how recently, companies are responding positively and want to employ people with ASD. Some companies even seek out employees with ASD. For the avatar interviews, a hidden human operator controls the experience. Four sessions with the avatar improved user's interview scores by 80%. This program is evidence of the effectiveness of robots in helping facilitate and guide social communication and interactions among people with ASD.



**MOSOCO A Mobile Assistive Tool to Support Children with Autism  
Practicing Social Skills in Real-Life Situations**

Lizbeth Escobedo, David H, Nguyen, LouAnne Boyd, Sen H. Hirano, Alejandro Rangel, Daniel Garcia-Rosas, Monica Tentori, and Gillian R. Hayes  
May 5, 2012

Association for Computer Machinery

Accessed: September 26, 2016

[http://www.gillianhayes.com/wp-content/uploads/2012/08/C29\\_chi2012\\_SocialCompass\\_cameraReady-v2.pdf](http://www.gillianhayes.com/wp-content/uploads/2012/08/C29_chi2012_SocialCompass_cameraReady-v2.pdf)

MOSOCO is an augmented reality mobile application for children with ASD. MOSOCO uses a mobile application to help children with ASD interact with one another and practice healthy social behaviors. MOSOCO helps guide social interactions by detecting people for the user to socialize with. Once a social interaction is initiated, MOSOCO helps guide its users through the conversation with social cues. This is an important study to consider because it combines interactive mobile and AR technology to encourage behavioral changes in children with ASD. MOSOCO does not use biofeedback.

**Positive behavioral and electrophysiological changes following  
neurofeedback training in children with autism**

J.A. Pineda, D. Brang, E. Hecht, L. Edwards, S. Carey, M. Bacon, C. Futagaki, D. Suk, J. Tom, C. Birnbaum, A. Rork

November 13, 2007

Research in Autism Spectrum Disorders

Accessed: September 29, 2016

<http://dx.doi.org/10.1016/j.rasd.2007.12.003>

This study tests the idea that neurofeedback training can help brain wave dysfunctions, resulting in improved behaviors in children with ASD. The study found that its participants improved their ATEC scores, and increased their ability to maintain focus. This study suggests that neurofeedback can be an effective treatment possibility for children with ASD.

**Postsecondary Education and Employment Among Youth With an Autism Spectrum Disorder**

Paul T. Shattuck, Sarah Carter Narendorf, Benjamin Cooper, Paul R. Sterzing, Mary Wagner, and Julie Lounds Taylor

February 16, 2012

American Academy of Pediatrics

Accessed: October 5, 2016

Doi: 10.1542/peds.2011-2864

Norton discusses research finding that young people with ASD are less likely to go to college or get a job in comparison to their peers with other disabilities. Norton goes on to discuss how within the last decade, ASD diagnoses have dramatically increased. Although the rate of ASD diagnoses has increased, little research has been done on how kids with ASD function after high school. Shattuck found that people with ASD who were of a low socio-economic background were at an even greater risk of not furthering their education and/or maintaining a job. Shattuck deduces that the cause of this is attributed to lack of: access of services, social connections, and employment connections for impoverished people with ASD. Shattuck says that special education programs should include a transition plan for post-high school years for those with ASD.

**Self-Adjusting Biofeedback with a Dynamic Feedback Signal Set (DyFSS)**

Laurence I. Sugarman, Brian L. Garrison, Anna E. Hope<sup>1</sup>, Stephen Jacobs, Alex J. Glade, Michael R. Wezalis, Kelsey L. Williford

The Center for Applied Psychophysiology and Self-Regulation at RIT,

Accessed October 27, 2016

<http://scholarworks.rit.edu/cgi/viewcontent.cgi?article=1018&context=eatc>

The authors discuss how autonomic dysregulation with anxiety presents challenges for children with ASD and how Peripheral Autonomic Biofeedback Training (PABT) is a promising solution for managing anxiety and ASD symptoms. Sugarman and authors discuss what DyFSS is and how it is a core feature of autonomic regulation training. PABT utilizes: skin conductance level, skin temperature, low frequency heart rate variability, and respiratory rate, feeds back these signals to the user, and the user learns how to change them through directions. The user then learns how to control them and apply these skills to their everyday life.

**Social Skill Deficits and Anxiety in High-Functioning Adolescents with Autism Spectrum Disorders**

Scott Bellini

Summer 2004

Focus on Autism and Other Developmental Disabilities

Sage Publications, Inc.

Accessed: November 6, 2016

<http://search.proquest.com.ezproxy.rit.edu/docview/205057377?accountid=108>

Bellini discusses how a abnormal number of children with ASD experience anxiety levels that are much greater than the average person. This study shows the influence anxiety has on people with ASD and how long-term anxiety management is important in treating the symptoms of ASD.

**Specialisterne**

October 5, 2016

<http://usa.specialisterne.com>

Specialisterne is a 501(c)3 organization focused on services and programs for businesses in the community with an interest in gaining people with ASD as employees. Specialisterne educates corporate partners, schools, and government agencies on how to gain and maintain employees with ASD. Specialisterne educates people with ASD on career development and help participants find employment.

**Special Haven**

October 4, 2016

[http://www.specialhaven.org/Home\\_Page\\_2\\_2.html](http://www.specialhaven.org/Home_Page_2_2.html)

Special Haven provides multi-sensory environments for children and adults with Special Needs fora local community. Special Haven specializes in multi-sensory rooms and the benefit these rooms provide in removing stresses of the outside world for people with special needs.

**Slowing Down Emergency Rooms to Improve Autism Care**

Shefali Luthra

May 9, 2016

Kaiser Health News

Accessed: October 4, 2016

<https://spectrumnews.org/news/slowing-down-emergency-rooms-to-improve-autism-care/>

Luthra discusses how hospitals across the country are implementing separate accommodations for people with autism in their ERs due to an influx of patients with ASD. These rooms have sensorial toys, iPads, and dimmed lights. Luthra discusses special protocols certain hospitals take when interacting with patients who have ASD. These protocols include alerting doctors of the patient's ASD diagnosis so that they can adjust how they interact with their patients. One in forty-five children were diagnosed with ASD in 2014. This is a dramatic increase when compared to ASD diagnoses in 2000 being 1 in 150. Hospitals are an important community hub to consider as a location to provide educational materials and treatment services to people with ASD.

**Symptoms as Solutions: Hypnosis and Biofeedback for Autonomic Regulation in Autism Spectrum Disorders**

Laurence I. Sugarman, Brian L. Garrison &amp; Kelsey L. Williford

September 5, 2013

American Journal of Clinical Hypnosis

Accessed: October 0216

Doi: 10.1080/00029157.2013.768197

**Tantrums in Children with Disability and Developmental Delays  
Child and Youth Services, Disability Services**

October 2014

Accessed: October 6, 2016

[http://www.dcsi.sa.gov.au/\\_\\_data/assets/pdf\\_file/0018/13905/tantrums-in-children-with-disability-and-developmental-delays.pdf](http://www.dcsi.sa.gov.au/__data/assets/pdf_file/0018/13905/tantrums-in-children-with-disability-and-developmental-delays.pdf)

This child development resource sheet reviews tantrums in children with disabilities and developmental delays. It explains why tantrums occur, when they can occur, how to respond, prevention and early intervention methods.

**The ECHOES Technology-Enhanced Learning Environment: Facilitating Social Communication Skills in Children with Autism**

Rajendran, G, Porayska-Pomsta K, Smith T, Lemon O, Consortium TECHOES  
May 9, 2013

ECHOES Publication

The International Meeting for Autism Research

Accessed: September 20, 2016

<http://echoes2.org/?q=node/2>

ECHOES is an interactive and collaborative learning environment tool for children 5-7 years old with ASD. Participants work on social skills by collaborating with virtual characters and objects. Manageable goals are developed and adapted based on the needs of the participant. Customizable features are an important element when working with children with ASD to ensure an interactive game is engaging and inclusive.

**The Disconnection**

Emily Vossen

TEDx Talks

YouTube

Accessed: October 15, 2016

Emily Vossen gives a TED talk about the benefits of neurofeedback training in children with ASD and how people without ASD would also benefit from it. Vossen refers to neurofeedback training as yoga for the brain. She discusses how the brain is a muscle and open to being re-trained. She opened the Henry Vossen Center for children who have cognitive disorders, and implements neurofeedback training at this center. Vossen also discusses the disconnect that occurs between doctors, patients, families, and treatment centers.

**The Use of Virtual Reality Hypnosis with Two Cases of Autism Spectrum Disorder: A Feasibility Study**

David W. Austin, Jo-Anne M. Abbott, and Colin Carbis

June 2008

John Wiley, Chichester UK

Doi: 10.1002/ch.349

Accessed: November 3, 2016

This study considers Virtual Reality (VR) technology as a means to treat symptoms of ASD in children. The study involved two boys ages 14 and 15 with 4 sessions over 2 weeks. The study looked at whether VR would reduce anxiety levels in children with ASD. Results suggested that VR did not have a positive effect in treating symptoms of ASD. However the parents of the participants said that they would utilize this technology if it were an available treatment option for their son. Each set of parents noticed increased levels of focus in their son as a result of VR technology being used as a therapeutic application.

**Using Virtual Environments for Teaching Social Understanding to 6 Adolescents with Autistic Spectrum Disorders**

Peter Mitchell, Sarah Parsons, and Anne Leonard

August 2006

Journal of Autism and Developmental Disorders

Accessed November 1, 2016

Doi: 10.1007/s10803-006-0189-8

The authors discuss how six teenagers with ASD experience a Virtual Environment (VE) cafe, a video of a real cafe, and a video of buses. Participants chose where they would sit and why they would sit there for each situation. This study showed the potential in using VR technology as a treatment option and social skills tool for young adults with ASD.

## Methodology

### Design Inquiry

Can a mobile application and an immersive biofeedback exercise be an effective means for people with ASD to receive biofeedback therapy? Can we implement this strategy to sensory rooms by projecting biofeedback information in an exercise format and having users interact with it? Can designers more efficiently and effectively communicate medical jargon in a thoughtful and clear way for families, medical staff, and people with ASD?

### Target Audience

This thesis project focuses on people with autism ages six to twenty years old. However, the application is prototyped for a sixteen-year-old child with autism.

This thesis aims to unify medical professionals, people with ASD and treatment facilities. This is done through the mobile application enabling participants to work together in a proactive approach toward health. This thesis serves as a therapeutic and preventative measure for people with autism. This thesis could be utilized in a medical facility. Additionally, this thesis brings to children with autism new forms of access to treatment technologies, which can lead to improvements in communication, behavior, and social interactions.

Design decisions were based on case studies of young adults with autism that experience social and behavioral impairments. Research suggest that young adults with autism benefit from biofeedback training with a medical professional in improving autonomic regulation.

**Young adult students with autism aged 12 - 18**

- Have personal goals they want to achieve.
- Desires improved social communication.
- Needs help coping with symptoms of stress and anxiety associated with autism.
- Wants biofeedback exercises to be immersive and engaging.

**Medical professional who specialize in young adults with autism**

- Utilize biofeedback treatments for young adults with autism.
- Carries out biofeedback treatment at medical facility using a computer screen and biofeedback technology.
- Wants a more immersive experience for patients when implementing biofeedback exercises.

**Considerations**

Tech-Savvy	Technologically Challenged
Claustrophobia	Agoraphobia
Aged 6-12	Aged 18+
Early Adopter	Late Majority
Verbal	Non Verbal
Sensitive	Unresponsive



## User Personas

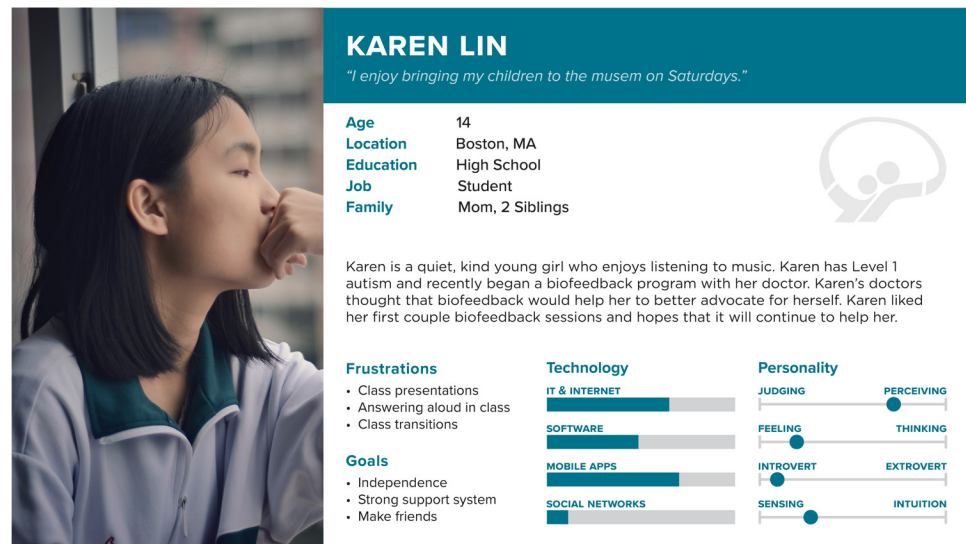


Figure 1. Persona 1

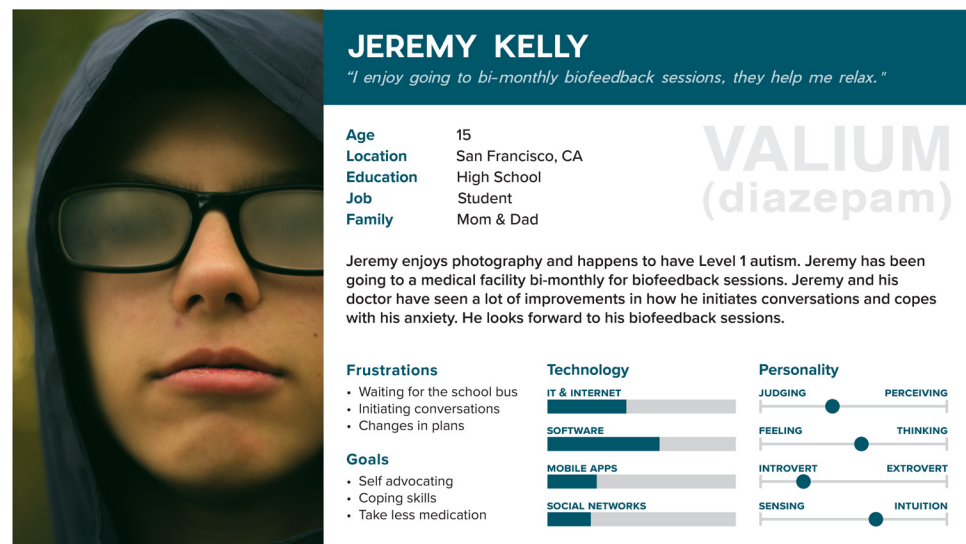


Figure 2. Persona 2

## User Personas (continued)

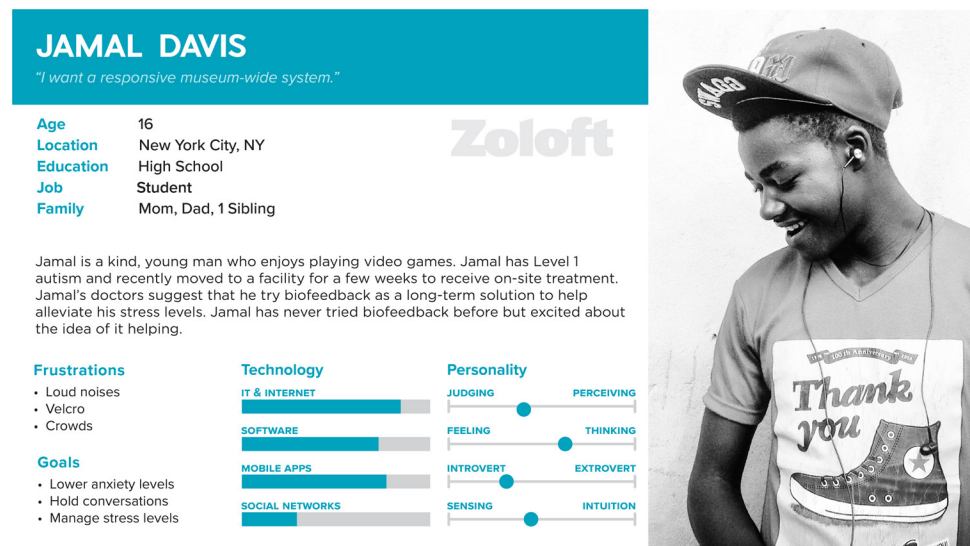


Figure 3. Persona 3

## **User Needs & Desires**

### **Young Adult Students with Autism**

1. Incentive to participate in biofeedback
2. Excellent application to device integration
3. Comfortable
4. Useful
5. Privacy Controls
6. Sense of self-awareness and goals

### **Medical Professional who Specializes in Young Adults with Autism**

1. Incentive to provide this interactive biofeedback system
2. Ability to control and adjust biofeedback session depending on patient
3. Doctor view versus patient view of mobile application
4. Ability to view biofeedback session data and patient progress
5. Privacy Controls

## Goals & Objectives

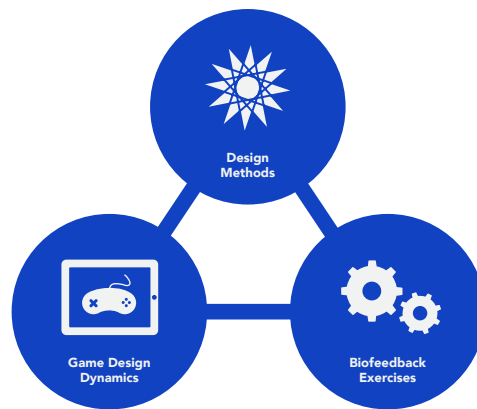
To create an immersive experiences using user-experience research and interaction design principles that will allow users to practice a biofeedback exercise. Main objectives will include: exploring new innovative uses for current technology as well as the development of a technology system that will allow users to visualize, understand, and perform the biofeedback exercise.

### Objectives

1. Clearly communicate process of the biofeedback exercise
2. Provide medical professionals and their patients with a better way to carry out biofeedback exercises
3. Create a sense of ownership and connection between a user and their biofeedback through the exercise and mobile application.
4. Motivate medical professionals and their patients to use the mobile application in conjunction with the biofeedback environment.

## Design Ideation

The main goal of this thesis is to integrate design methods with research findings on the benefits of biofeedback trainings for people with ASD. This will be done through game design dynamics in the form of a one-minute motion graphics piece featuring a biofeedback exercise, and a non-working, mobile application. Both of these deliverables will educate and support people with ASD through accessible therapeutic treatments implemented at a medical facility. Additionally, a conical-shaped structure will be built and have the one-minute motion graphics piece, depicting a biofeedback session, projected on to it. Users will be able to walk into this structure and view the motion graphics piece.



Design Interactions

## SynApps User Experience Map

A user experience map (Figures 4-6) was developed to better understand user scenarios, how the user interacts with the mobile app and biofeedback exercise, problems, and questions.

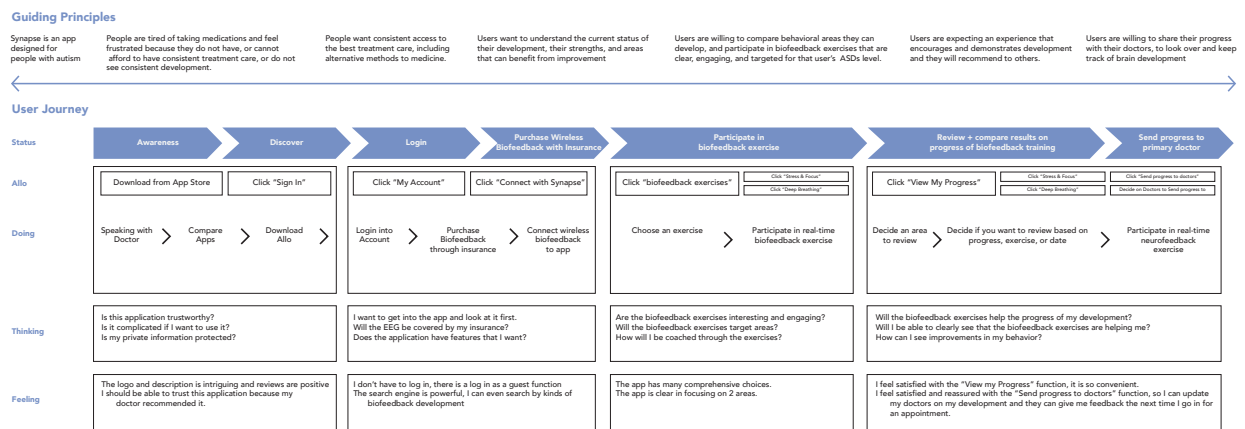


Figure 4. User Experience Map

## SynApps User Experience Close-Up 1 of 2

### Guiding Principles

Synapse is an app designed for people with autism

People are tired of taking medications and feel frustrated because they do not have, or cannot afford to have consistent treatment care, or do not see consistent development.

People want consistent access to the best treatment care, including alternative methods to medicine.

Users want to understand the current status of their development, their strengths, and areas that can benefit from improvement



### User Journey

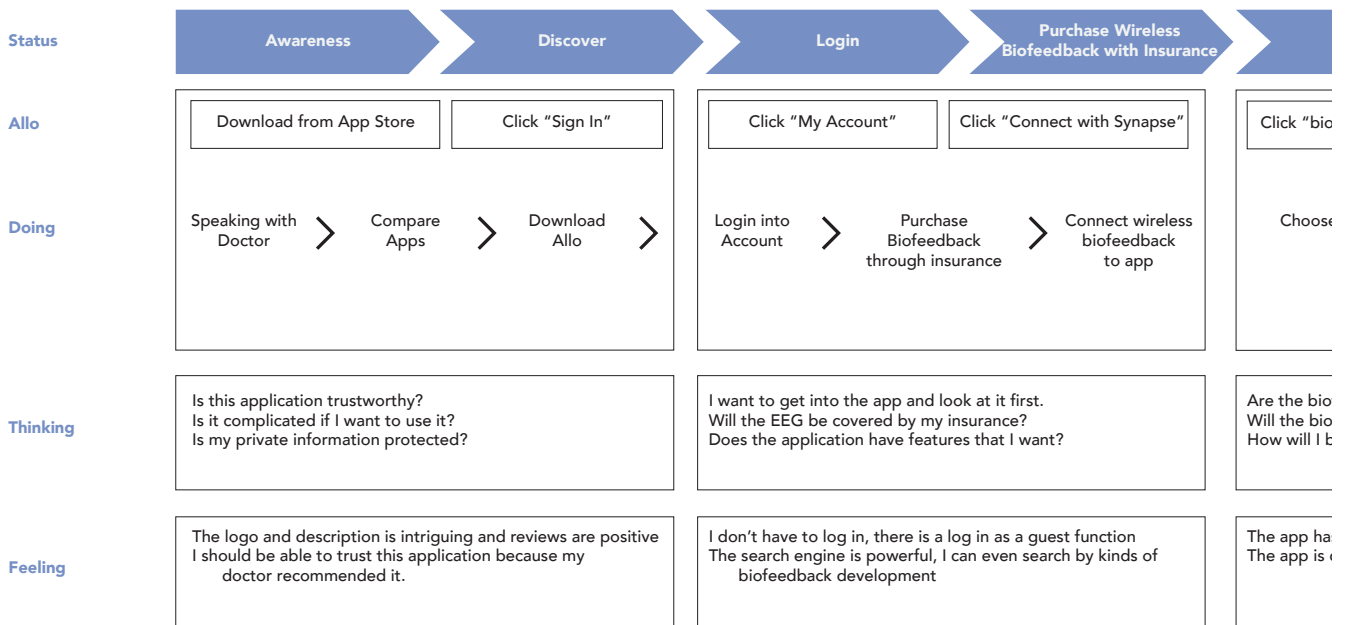


Figure 5. User Experience Map (Close up 1)

## SynApps User Experience Close-Up 2 of 2

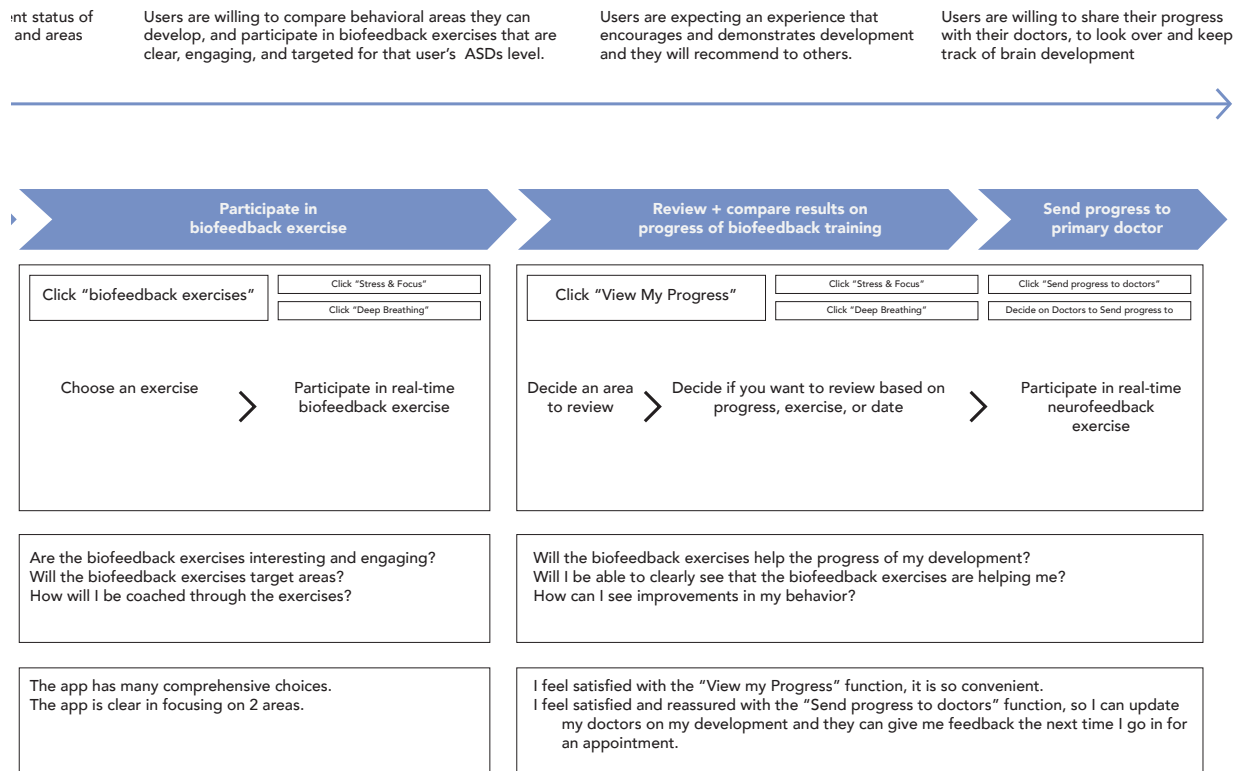


Figure 6. User Experience Map (Close up 2)



## Mobile Application User Flow Chart

A user flow chart (Figures 7-10) was created for the mobile application to outline how the user navigates through the app.

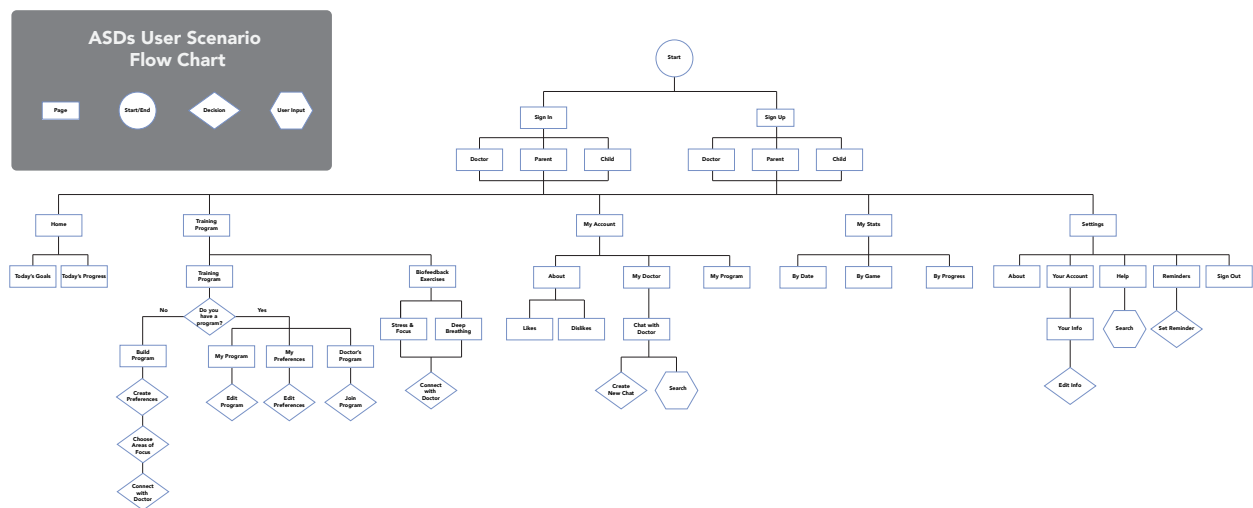


Figure 7. User Flow Chart

## Mobile Application User Flow Chart Close-Up 1 of 3

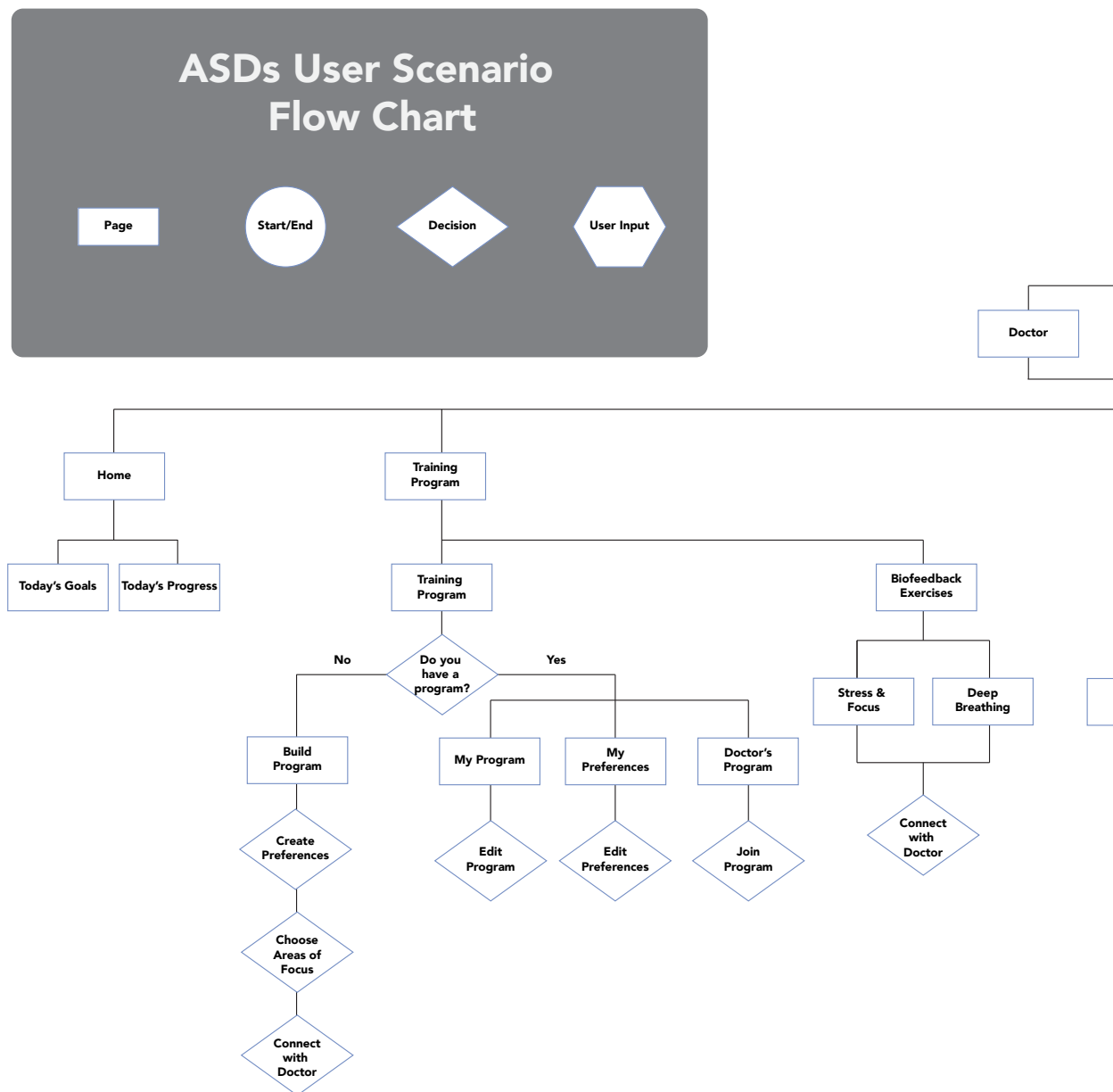


Figure 8. User Flow Chart (Close Up 1)

## Mobile Application User Flow Chart Close-Up 2 of 3

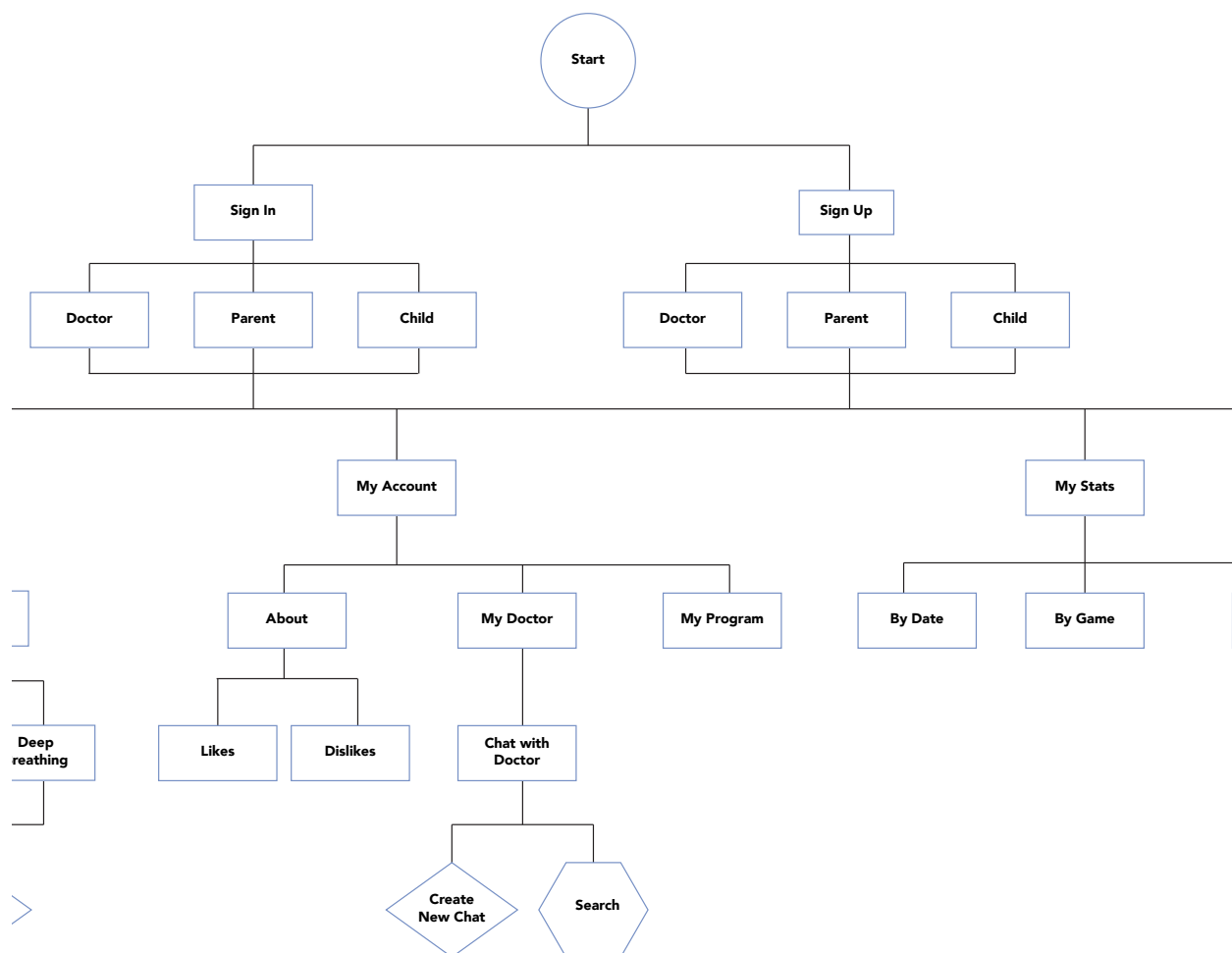


Figure 9. User Flow Chart (Close Up 2)

## Mobile Application User Flow Chart Close-Up 3 of 3

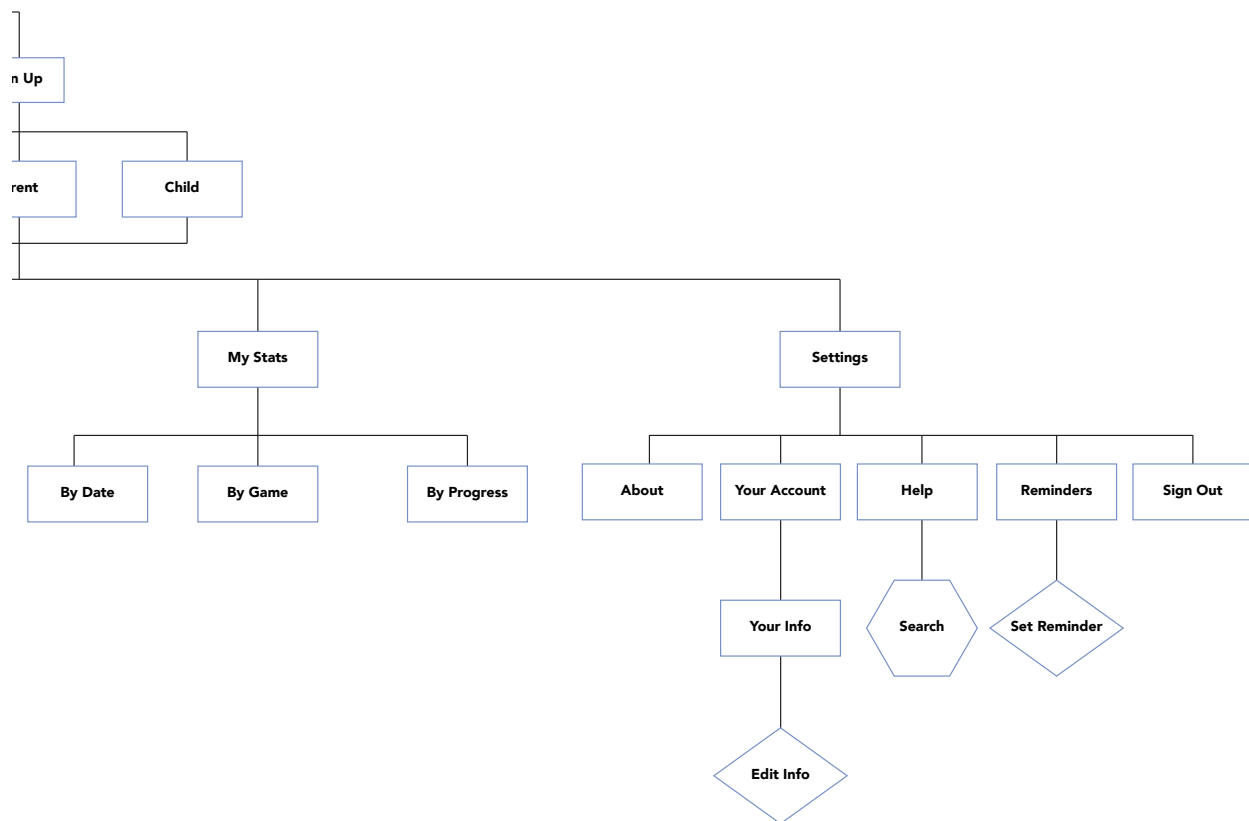


Figure 10. User Flow Chart (Close Up 3)

## Mobile Application Grid Structure

A 12 column grid (Figure 11) for an iPad was utilized in creating the application's layout, structure, and visual heirarchy. A 12 column grid was chosen because material design's responsive UI is based upon a 12 column grid structure. Additionally, the proportions can be broken down into clean and even columns for varying medical information.

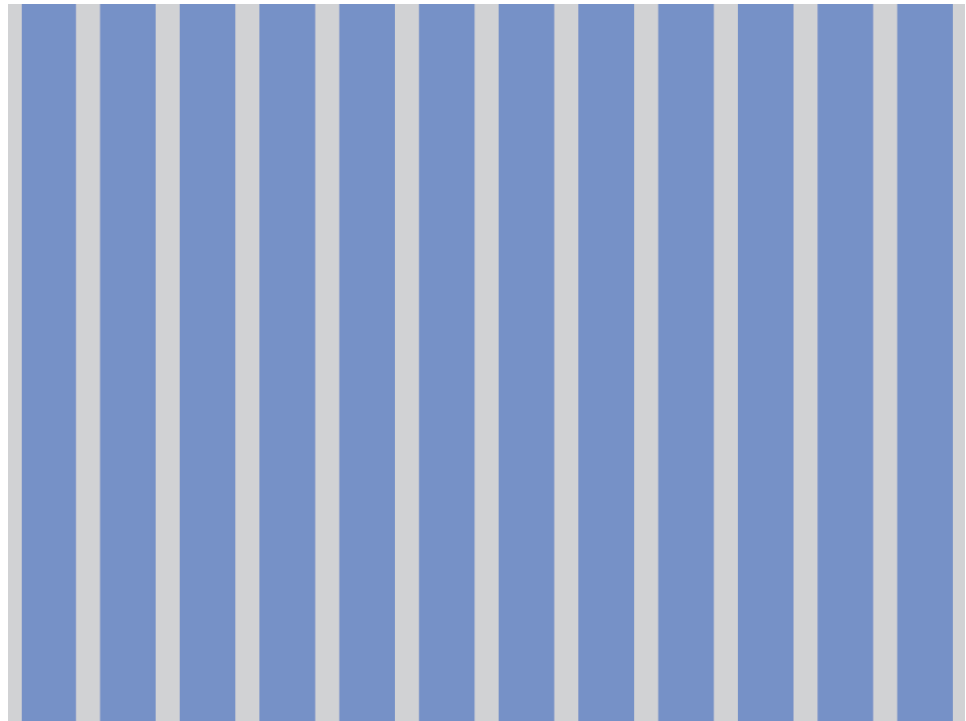


Figure 11. Mobile Application Grid Structure

## Mobile Application Paper Prototype

Initially, paper prototypes were developed. The iPad paper prototypes (see Figures 12-24) were tested on 3 people. Paper prototypes were tested to collect user feedback on navigation and flow. Feedback was done through observation and a survey. The user feedback informed the creation of the first iteration of wireframes.

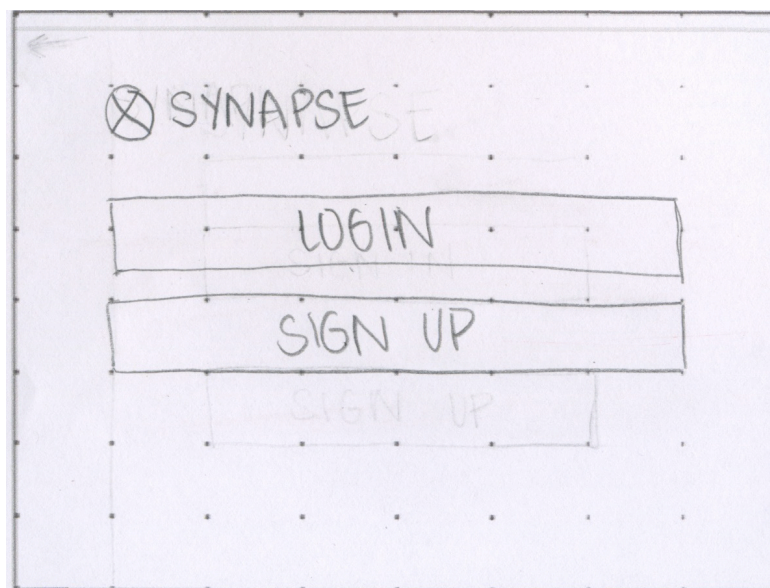


Figure 12. Paper Prototype 1

## Mobile Application Paper Prototype (Continued)

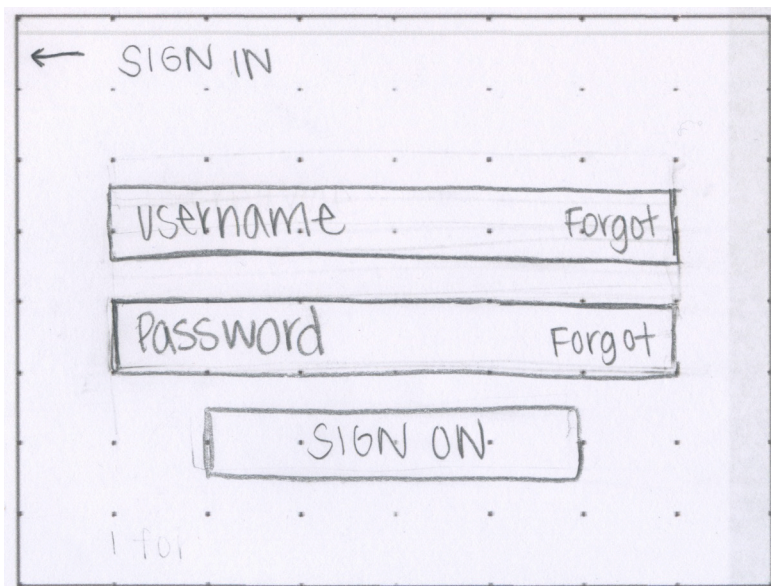


Figure 13. Paper Prototype 2

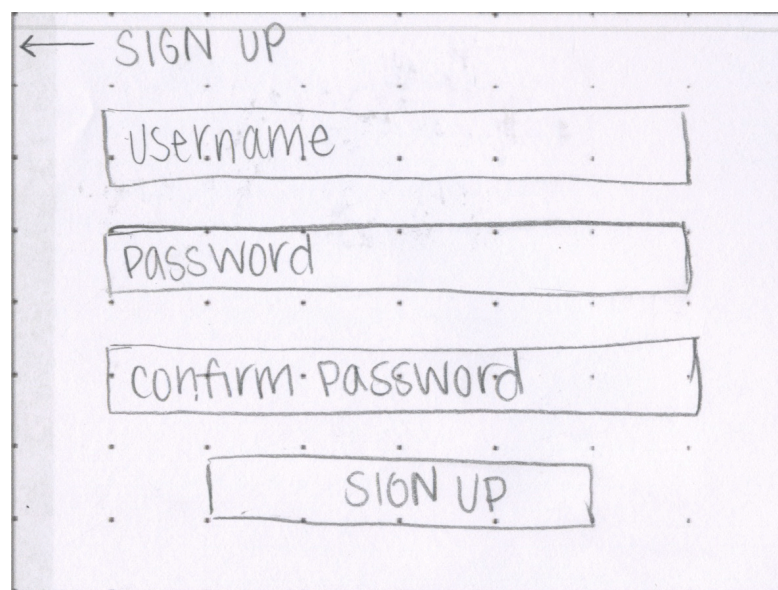


Figure 14. Paper Prototype 2



## Mobile Application Paper Prototype (Continued)

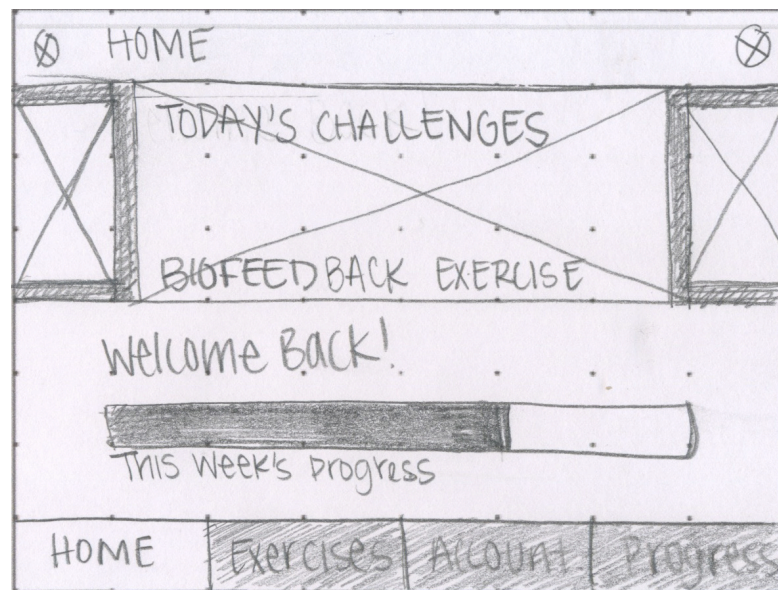


Figure 15. Paper Prototype 3

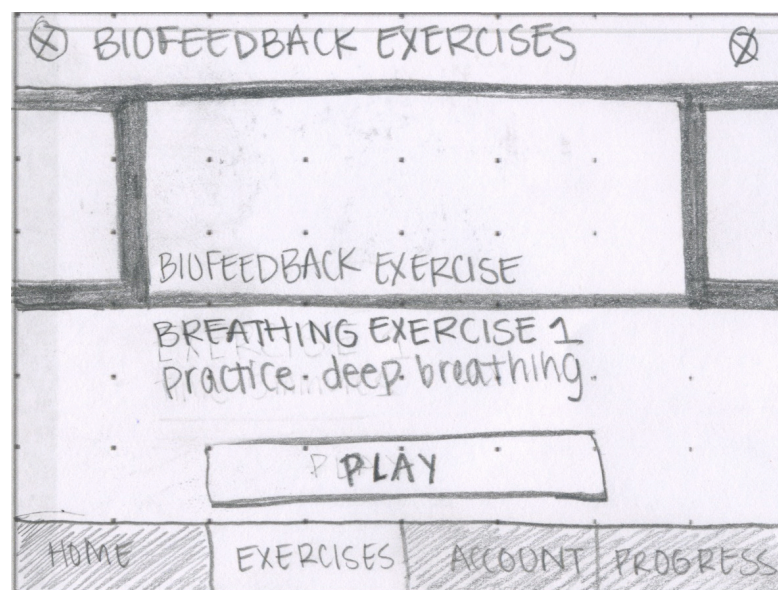


Figure 16. Paper Prototype 4



## Mobile Application Paper Prototype (Continued)

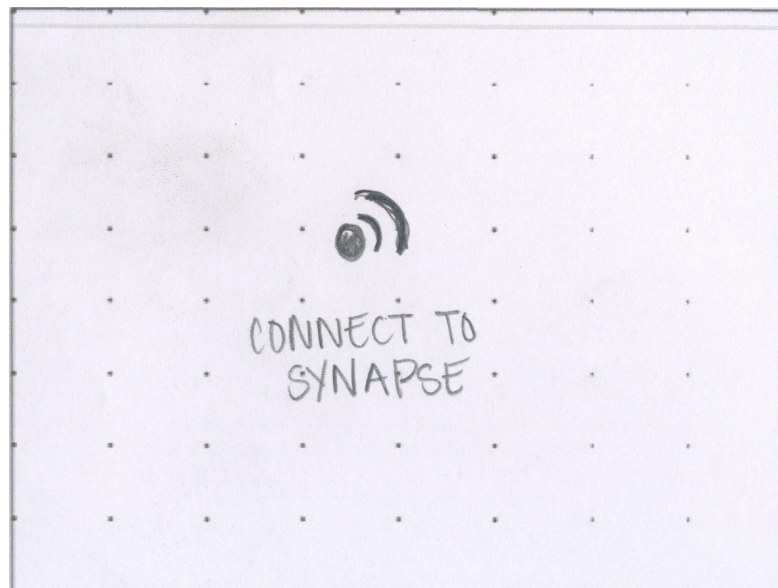


Figure 17. Paper Prototype 2

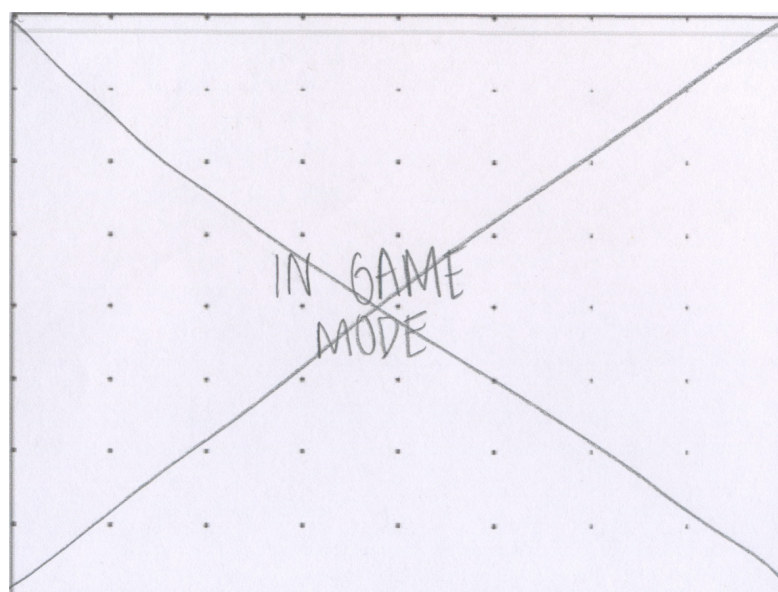


Figure 18. Paper Prototype 5

## Mobile Application Paper Prototype (Continued)

**USER ACCOUNT**

ABOUT MY DOCTOR PROGRAM

USER	Jamal Davis	EDIT
ADDRESS	3 Knickerbocker Ln.	EDIT
LIKES	Reading, Color Blue	EDIT
DISLIKES	Crowds, Loud Music	EDIT

HOME EXERCISES ACCOUNT PROGRESS

Figure 19. Paper Prototype 3

**USER ACCOUNT**

ABOUT MY DOCTOR PROGRAM

DOCTOR	Dr. Sugarman	EDIT
LOCATION	6 White Spruce Blvd	EDIT
APPOINTMENTS	MAY 6 at 5PM	EDIT
PHONE	585-255-5555	EDIT

HOME EXERCISES ACCOUNT PROGRESS

Figure 20. Paper Prototype 2



## Mobile Application Paper Prototype (Continued)

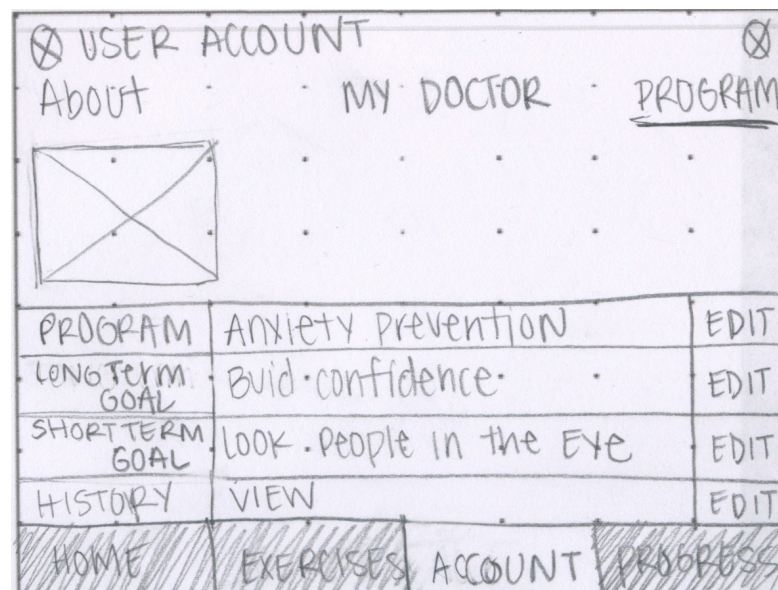


Figure 21. Paper Prototype 3

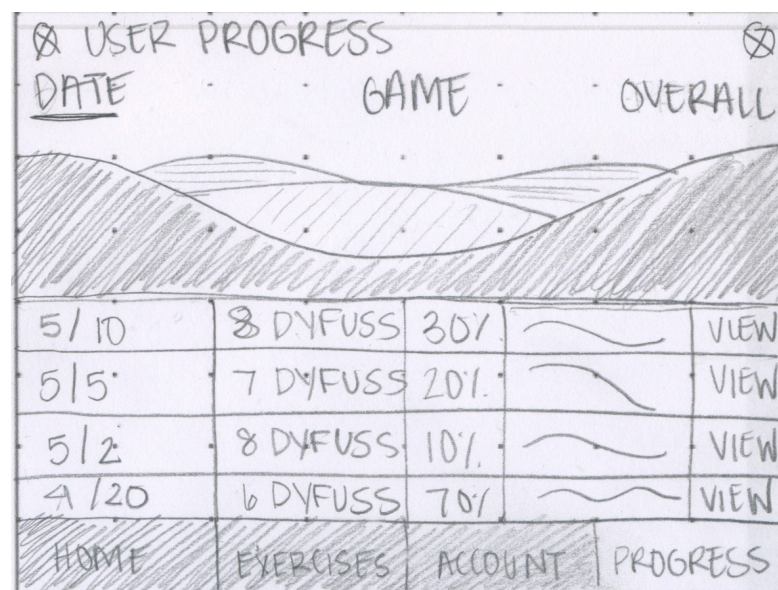


Figure 22. Paper Prototype 4

## Mobile Application Paper Prototype (Continued)

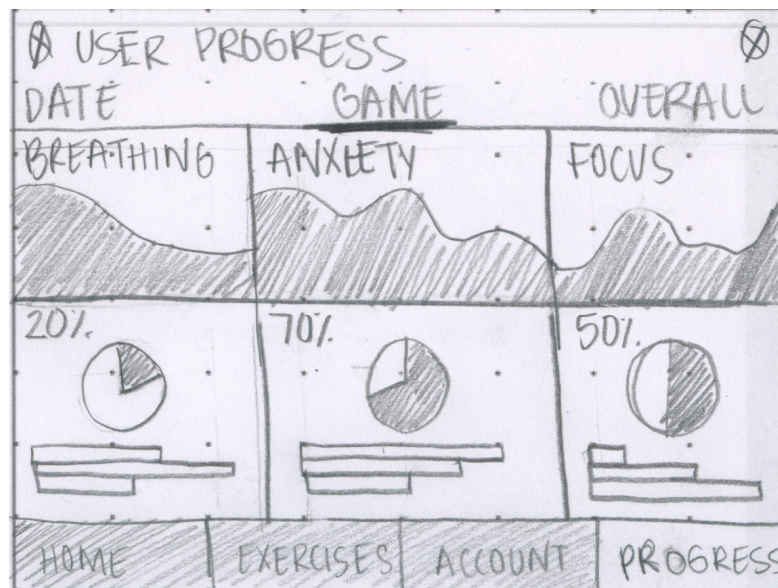


Figure 23. Paper Prototype 5

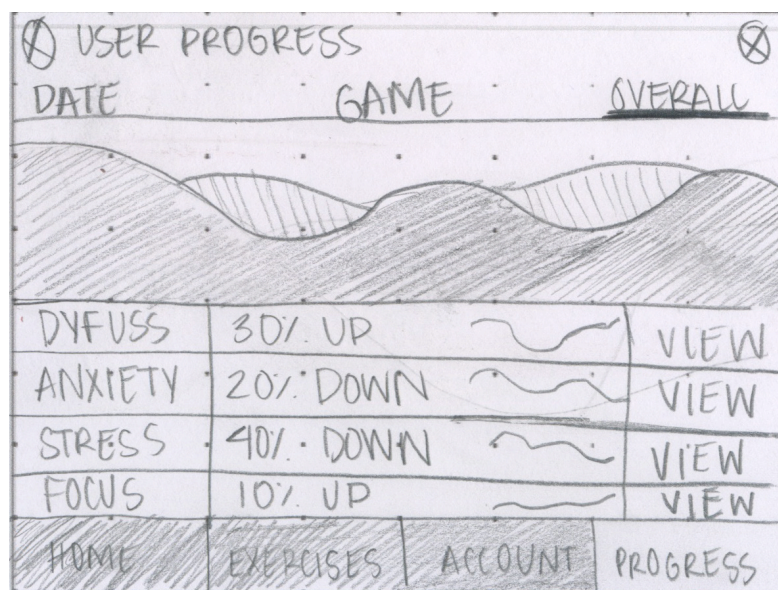


Figure 24. Paper Prototype 4

## Mobile Application Paper Prototype User Testing







### Feedback 1

Paper prototype wireframes were developed (Figures 12-24). User testing was conducted and feedback was received through a combination of various discussions with additional designers and topic professionals.

Initial paper prototypes blocked out main content areas.

- Home
- Biofeedback Exercise
- User Account
- Biofeedback Progress

### Feedback & Considerations

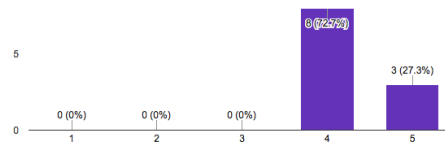
-  - Include health information in user sign up.
-  - Include quick description about biofeedback exercise.
-  - User Account should show health information.
-  - Only put exercise in Biofeedback exercise page, not on home page.
-  - Easy to navigate through each page.
-  -Complex information is pretty legible and understood.

## Mobile Application Paper Prototype User Testing

Paper prototype user testing (Figure 25) was conducted and feedback was received through a survey with additional designers and topic professionals.

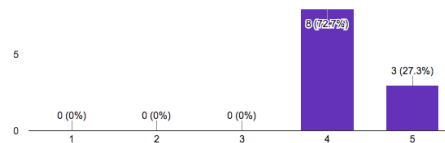
The layout is effective and easy to navigate.

11 responses



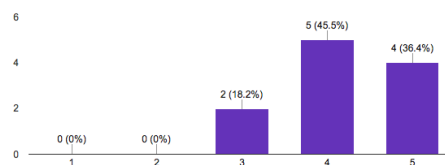
The amount of content is appropriate.

11 responses



Button placement is effective

11 responses



The bottom toolbar navigation is clear and understandable.

11 responses

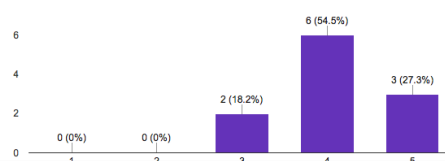


Figure 25. Paper Prototype 4

## Mobile App Lo-Fidelity Wireframes Iteration 1

Initially, paper prototypes were developed. The iPad paper prototypes (see Figures ) were tested on 3 people. Paper prototypes were tested to collect user feedback on navigation and flow. Feedback was done through observation and a questionnaire. The user feedback informed the creation of the first iteration of wireframes.



Figure 26. Splashscreen

## Mobile App Lo-Fidelity Wireframes Iteration 1

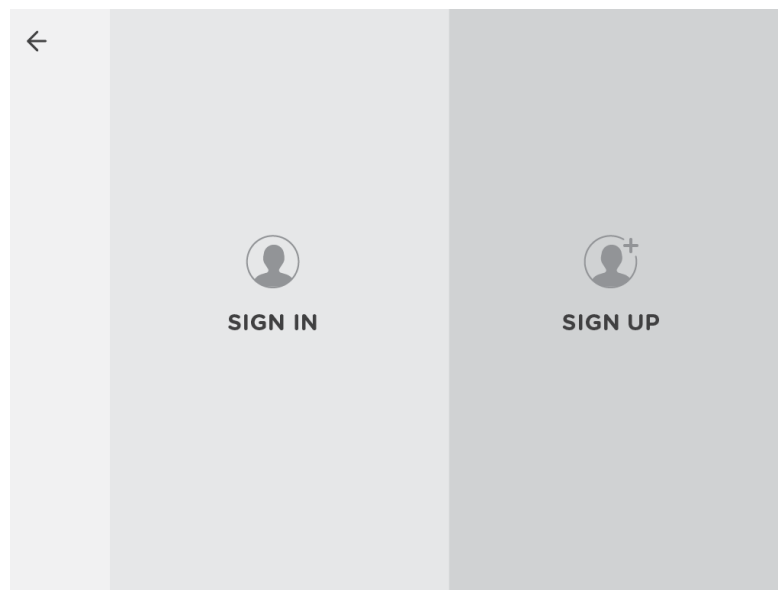


Figure 27. Sign In or Sign Up

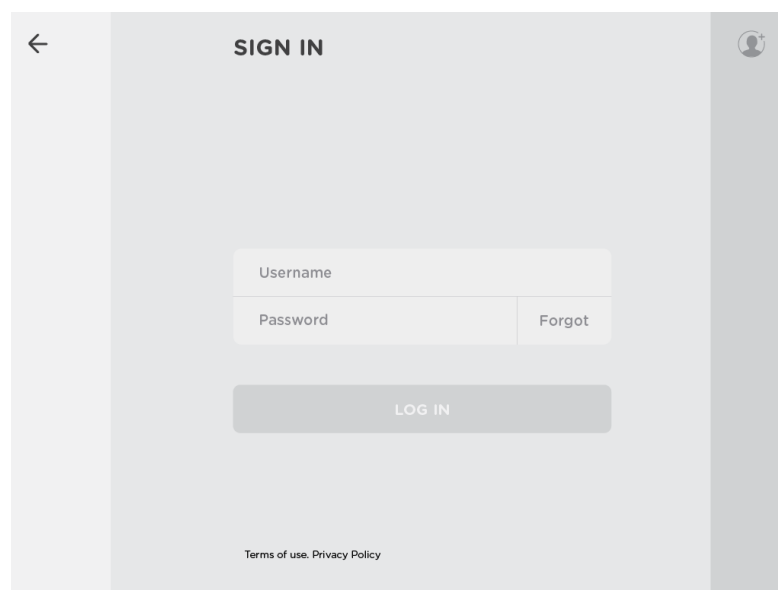
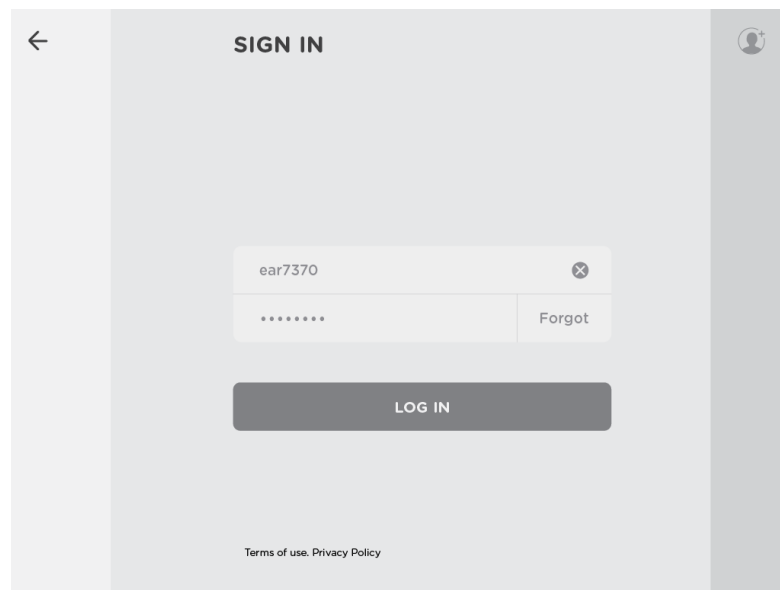


Figure 28. Sign In Screen 1

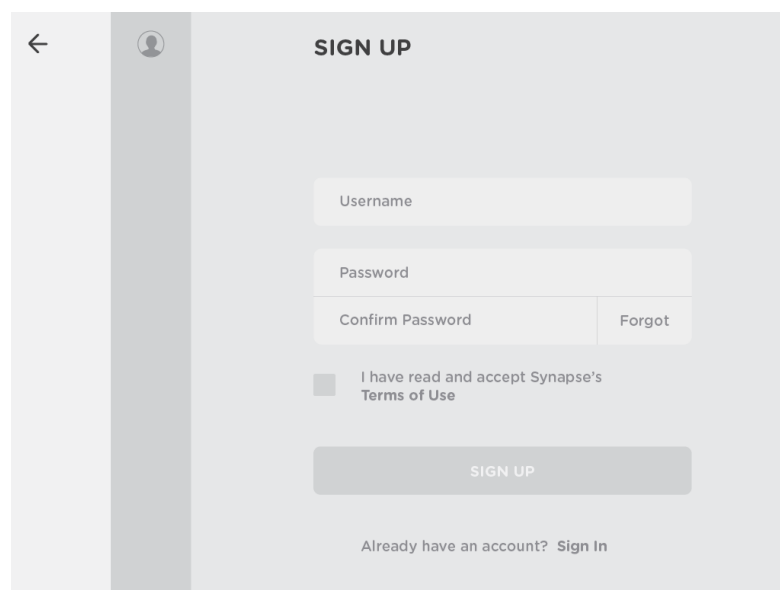


## Mobile App Lo-Fidelity Wireframes Iteration 1



A lo-fidelity wireframe for a mobile app's sign-in screen. The screen has a light gray background. At the top left is a back arrow icon. At the top center is the text "SIGN IN". At the top right is a user profile icon. Below the title, there are two input fields: the first contains the text "ear7370" and has a clear (X) button; the second contains seven dots and has a "Forgot" link to its right. Below these fields is a large, dark gray button with the text "LOG IN". At the bottom center, there is a link that says "Terms of use. Privacy Policy".

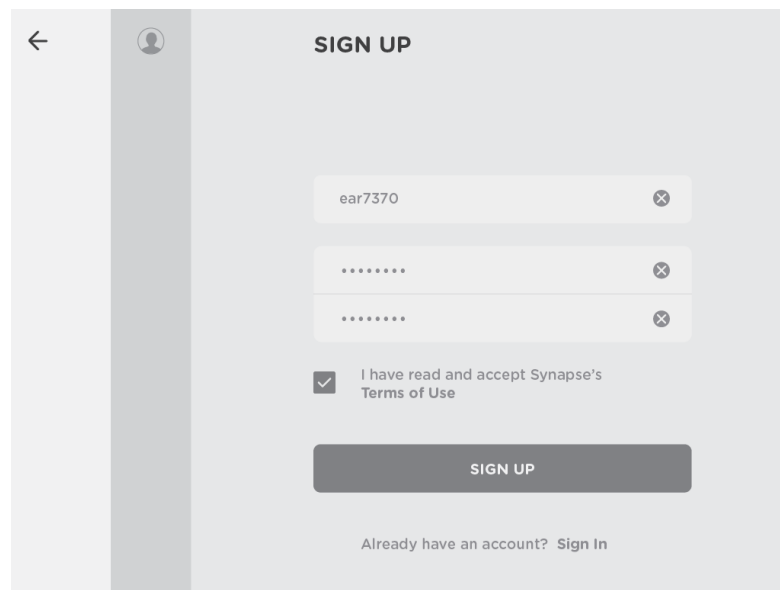
Figure 29. Sign In Screen 1 Feedback



A lo-fidelity wireframe for a mobile app's sign-up screen. The screen has a light gray background. At the top left is a back arrow icon. At the top center is the text "SIGN UP". At the top right is a user profile icon. Below the title, there are three input fields: "Username", "Password", and "Confirm Password". The "Confirm Password" field has a "Forgot" link to its right. Below these fields is a checkbox with the text "I have read and accept Synapse's Terms of Use". Below the checkbox is a large, dark gray button with the text "SIGN UP". At the bottom center, there is a link that says "Already have an account? Sign In".

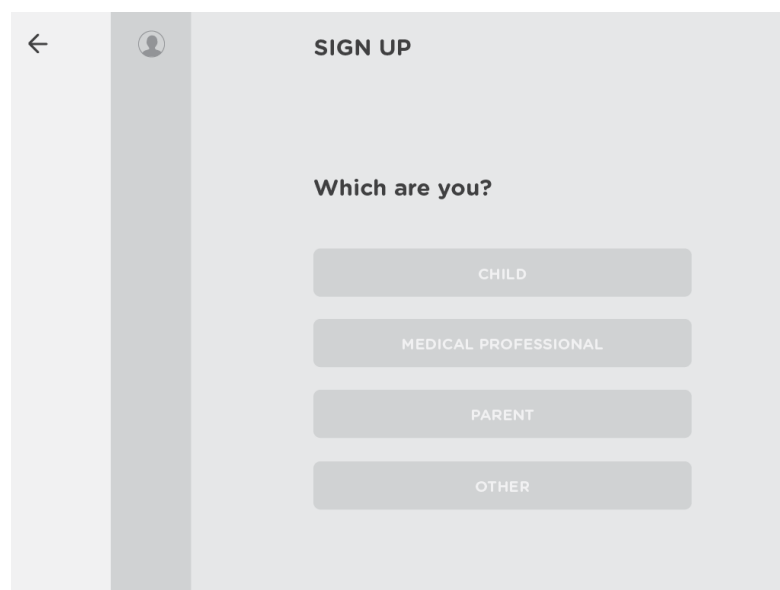
Figure 30. Sign Up Screen 1

## Mobile App Lo-Fidelity Wireframes Iteration 1



A lo-fidelity wireframe for a mobile app's sign-up screen. The screen has a light gray background. On the left, there is a vertical sidebar with a back arrow icon and a user profile icon. The main content area is titled "SIGN UP". It contains three input fields: the first has the text "ear7370" and a clear icon (X); the second and third are password fields with masked characters "....." and clear icons. Below the fields is a checkbox with a checkmark and the text "I have read and accept Synapse's Terms of Use". At the bottom of the form is a dark gray button labeled "SIGN UP". Below the button is a link that says "Already have an account? Sign In".

Figure 31. Sign Up Screen 1 Feedback



A lo-fidelity wireframe for a mobile app's sign-up screen, specifically for user profile selection. The screen has a light gray background. On the left, there is a vertical sidebar with a back arrow icon and a user profile icon. The main content area is titled "SIGN UP". Below the title is the question "Which are you?". There are four horizontal buttons stacked vertically, each with a label: "CHILD", "MEDICAL PROFESSIONAL", "PARENT", and "OTHER".

Figure 32. Sign Up User Profile

## Mobile App Lo-Fidelity Wireframes Iteration 1

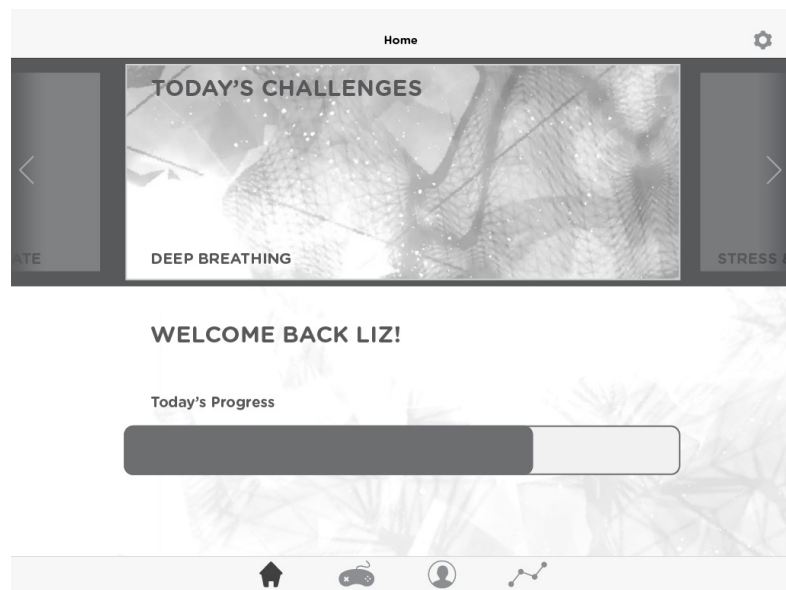


Figure 33. Patient Home Screen

## Mobile App Lo-Fidelity Wireframes Iteration 1

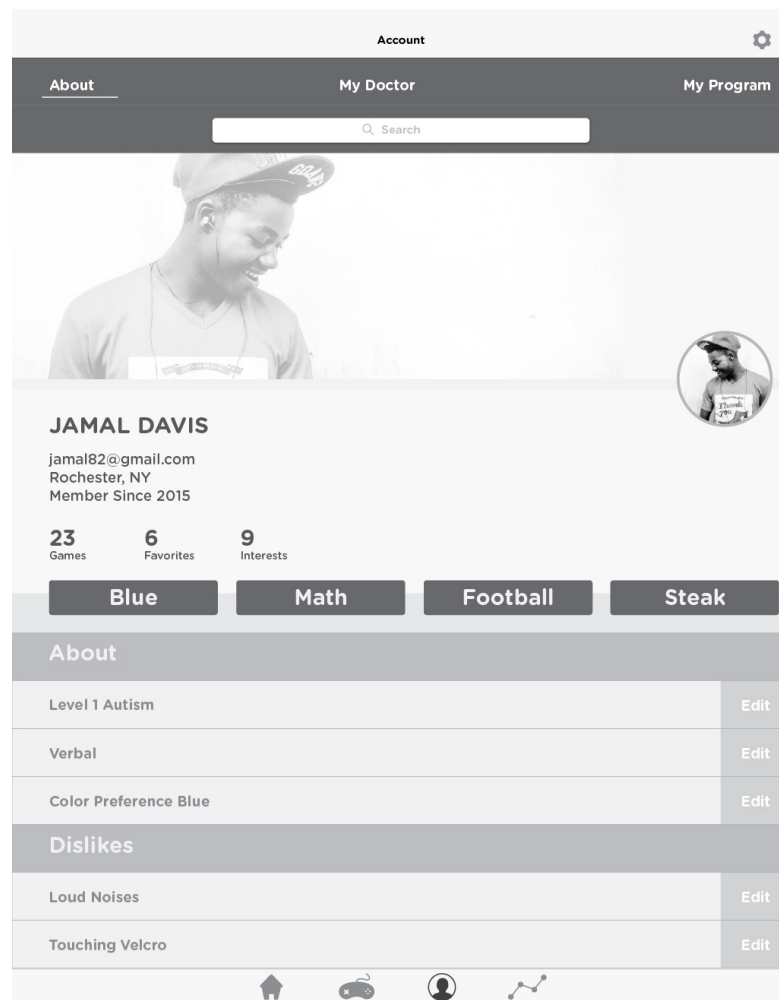


Figure 34. Patient Account Screen

## Mobile App Lo-Fidelity Wireframes Iteration 1

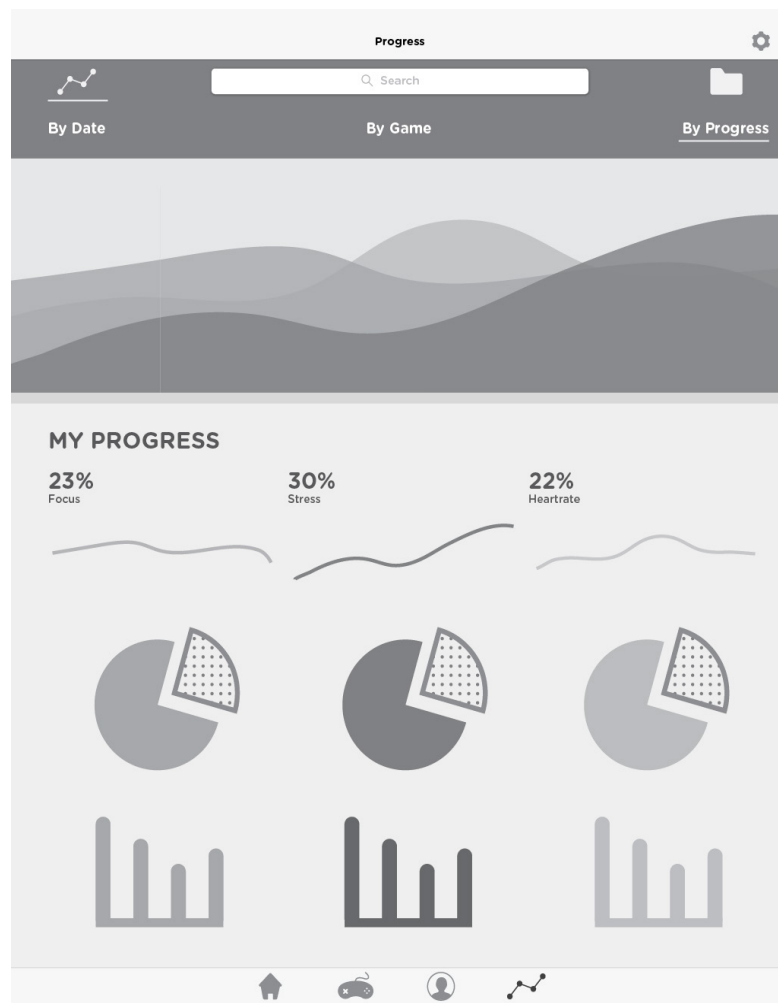


Figure 35. Patient Progress Screen

## Mobile App Lo-Fidelity Wireframes Iteration 1

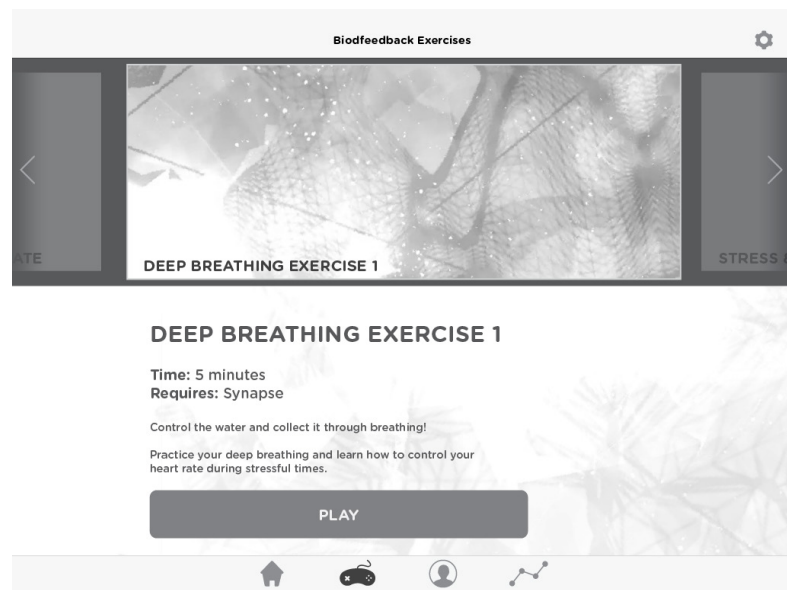


Figure 36. Patient Exercise Screen 1

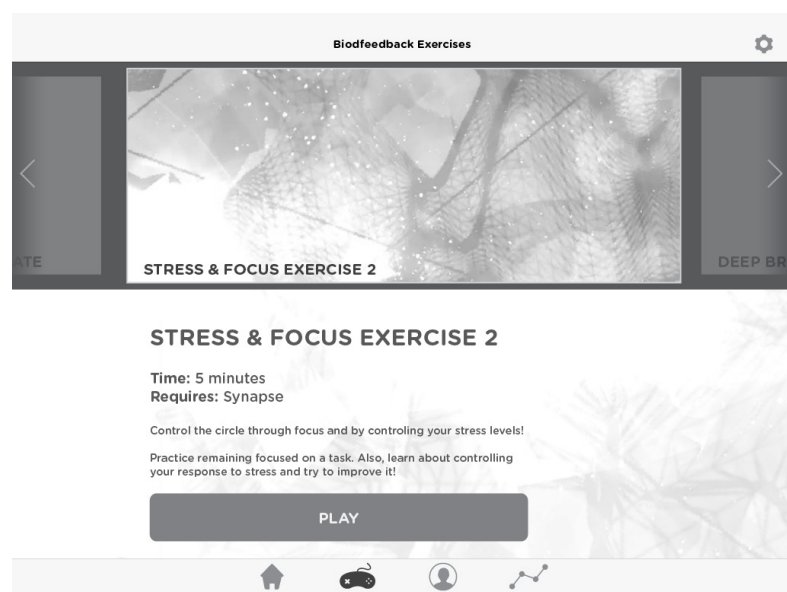
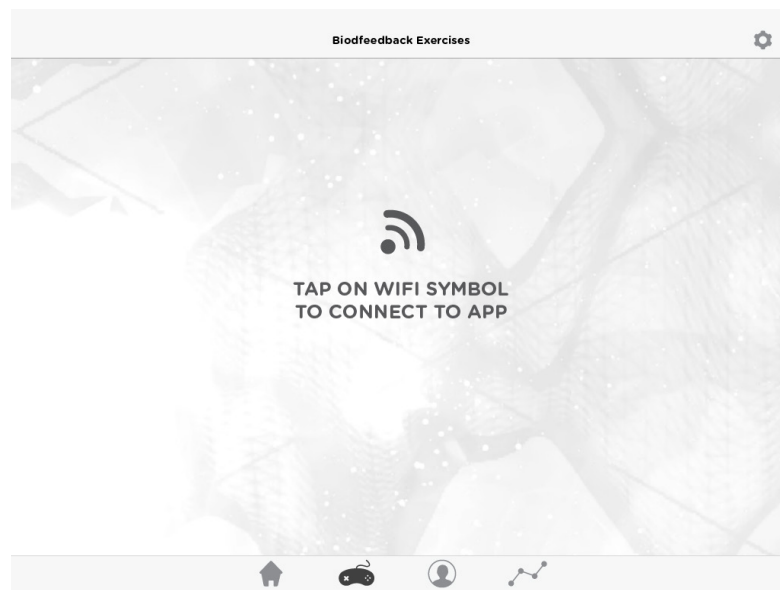


Figure 37. Patient Exercise Screen 2

## Mobile App Lo-Fidelity Wireframes Iteration 1



**Figure 38.** Patient Exercise Connect to SynApps Environment

## Mobile App Lo-Fi Wireframes Iteration 1 User Testing







### Feedback 1

Low-fidelity wireframes were developed (Figures 12-24). User testing was conducted and feedback was received through a combination of various discussions with additional designers and topic professionals.

Initial paper and low fidelity wireframes blocking out main content areas.

- Home
- Biofeedback Exercise
- Account
- Progress

### Feedback & Considerations

-  - Maintain consistent grid system.
-  - Follow horizontal or vertical layout.
-  - Provide different options for doctor versus patient application view.
-  - Don't need a connect to wifi screen, it creates confusion for user. Application will automatically connect and start-up session for user.
-  - Great idea, I like that the patient has an account.
-  - Tab navigation system is easy to use and allows oversight of the app.



## Mobile App Lo-Fidelity Iteration 1 User Scenario Testing

### Testing & Results

**Task 1** = Sign up for an account as a patient.

**Task 2** = Play a deep breathing exercise.

**Task 3** = Review your biofeedback progress in your account.

**Task 4** = Edit the disliked in your account.

Participant	Task 1	Task 2	Task 3	Task 4
1	Success	Success	Success	Success
2	Success	Success	Fail	Success
3	Success	Success	Success	Success
4	Success	Success	Success	Success
5	Success	Success	Success	Fail
6	Success	Success	Success	Success
7	Success	Success	Success	Success
8	Success	Fail	Success	Success
9	Success	Success	Success	Fail
10	Success	Success	Success	Success
Success	100%	90%	90%	80%

Figure 39. User Scenario Wireframe Iteration 1 Usability Testing

## Mobile App Lo-Fidelity Wireframes Iteration 2

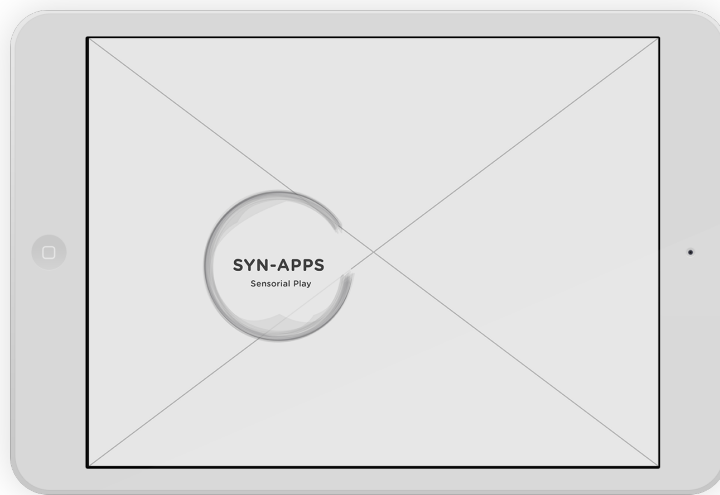


Figure 40. Splashscreen

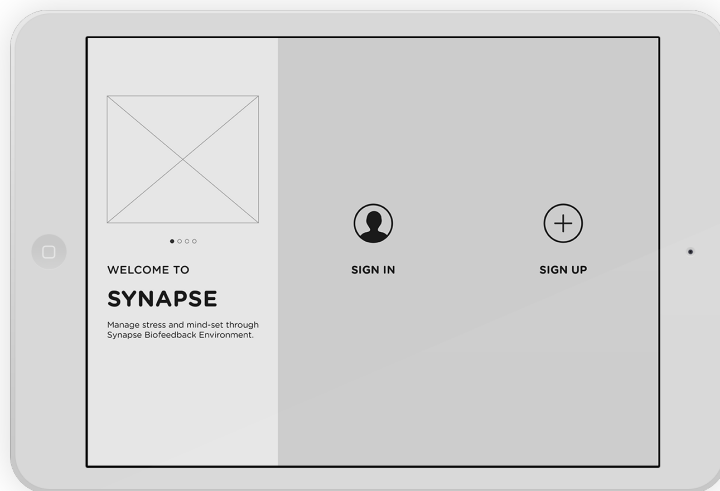


Figure 41. Sign In or Sign Up

## Mobile App Lo-Fidelity Wireframes Iteration 2

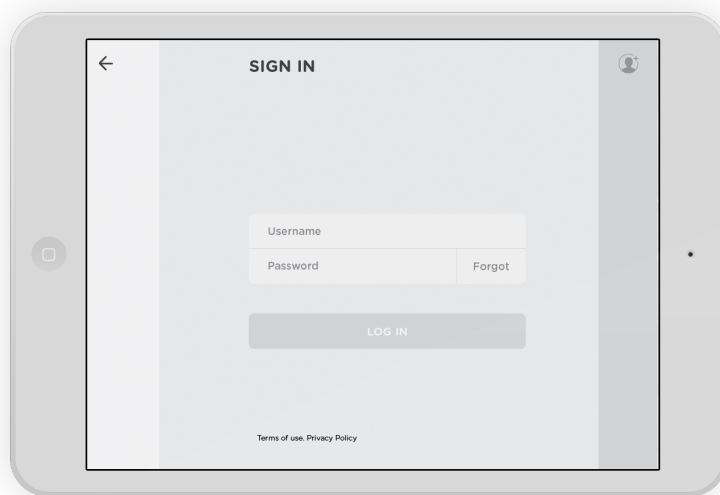


Figure 42. Sign Up User Purpose

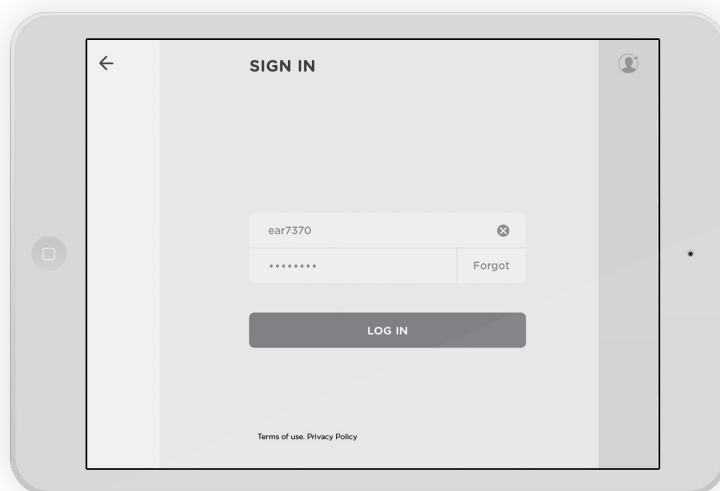


Figure 43. Doctor View: Sign Up User Profile 1

## Mobile App Lo-Fidelity Wireframes Iteration 2

A lo-fidelity wireframe of a mobile app's 'SIGN UP' screen. The screen is displayed on a tablet-like device. At the top left, there is a back arrow icon and a user profile icon. The title 'SIGN UP' is centered at the top. Below the title, there are three input fields: 'Username', 'Password', and 'Confirm Password'. To the right of the 'Confirm Password' field is a 'Forgot' link. Below these fields is a checkbox with the text 'I have read and accept Synapse's Terms of Use'. At the bottom of the form is a 'SIGN UP' button. Below the button is a link that says 'Already have an account? Sign In'.

Figure 44. Doctor View: Sign Up User Profile 1 Feedback

A lo-fidelity wireframe of a mobile app's 'SIGN UP' screen, showing a different state than Figure 44. The layout is identical, but the input fields are now populated with text. The 'Username' field contains 'ear7370'. The 'Password' and 'Confirm Password' fields contain six dots each. The 'I have read and accept Synapse's Terms of Use' checkbox is now checked. The 'SIGN UP' button is now a solid dark gray. The 'Already have an account? Sign In' link remains at the bottom.

Figure 45. Doctor View: Sign Up User Facility Information

## Mobile App Lo-Fidelity Wireframes Iteration 2

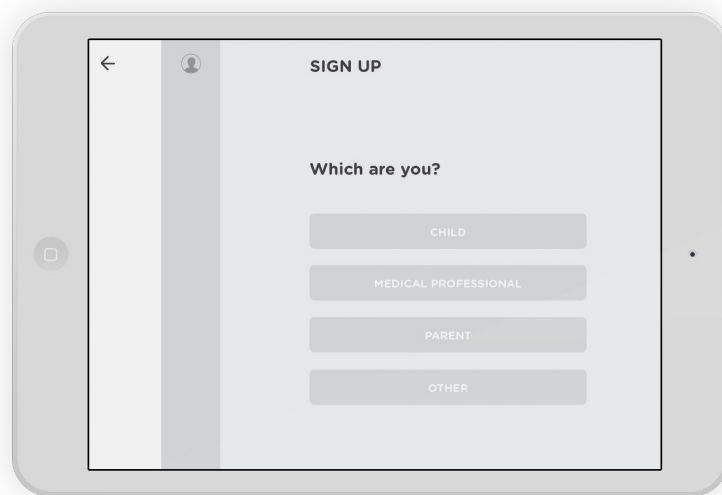


Figure 46. Doctor View: Sign Up User Facility Information Feedback

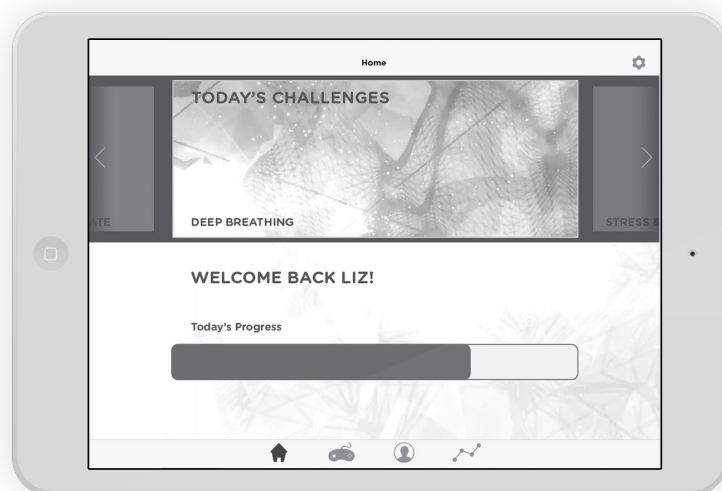


Figure 47. Doctor View: Sign In

## Mobile App Lo-Fidelity Wireframes Iteration 2

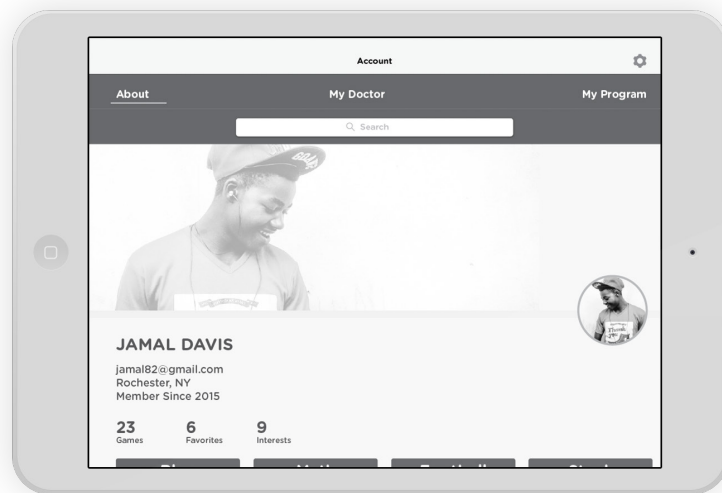


Figure 48. Doctor View: Sign In Feedback

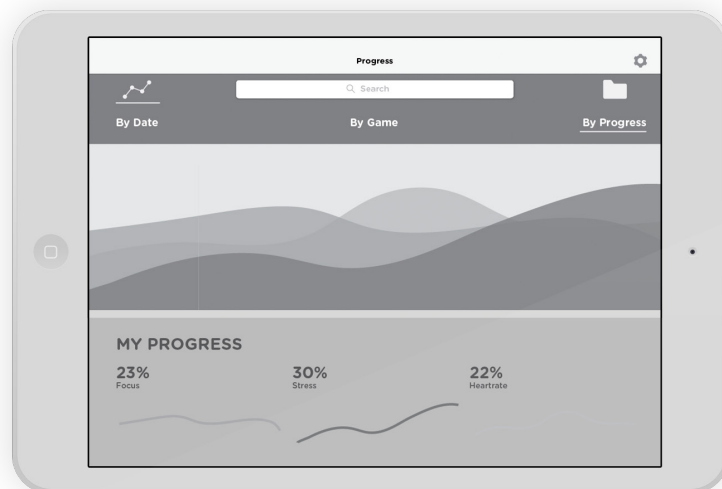


Figure 49. Doctor View: Appointments Screen

## Mobile App Lo-Fidelity Wireframes Iteration 2

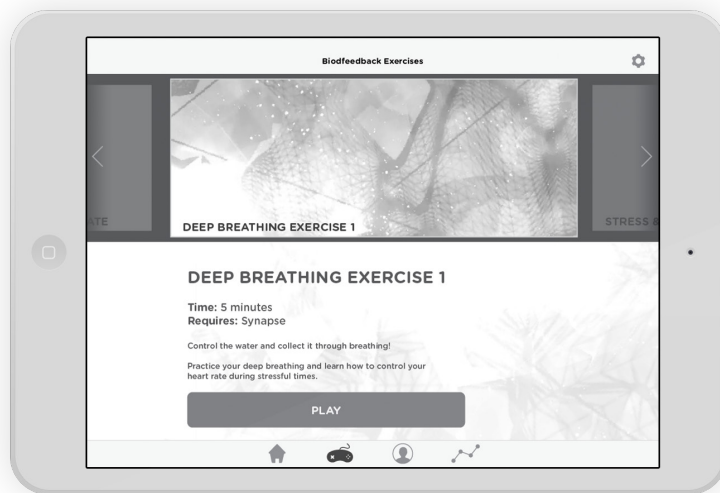
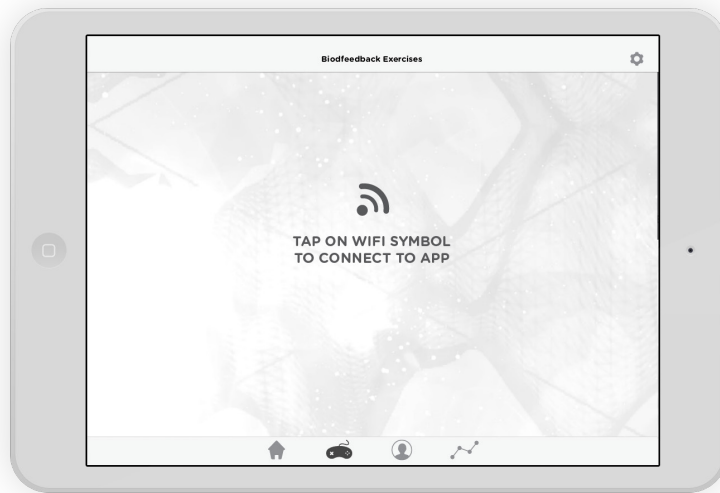


Figure 50. Doctor View: Biofeedback Exercise Screen - Adding Patient



Figure 51. Doctor View: Biofeedback Exercise Screen - Stress & Focus

## Mobile App Lo-Fidelity Wireframes Iteration 2



**Figure 52.** Doctor View: Biofeedback Exercise Screen - Deep Breathing

**Figure 53.** Doctor View: Biofeedback Exercise Screen - SynApps Syncing



## Mobile App Lo-Fidelity Wireframes Iteration 2



Figure 54. Doctor View: Biofeedback Exercise Screen - SynApps Synced

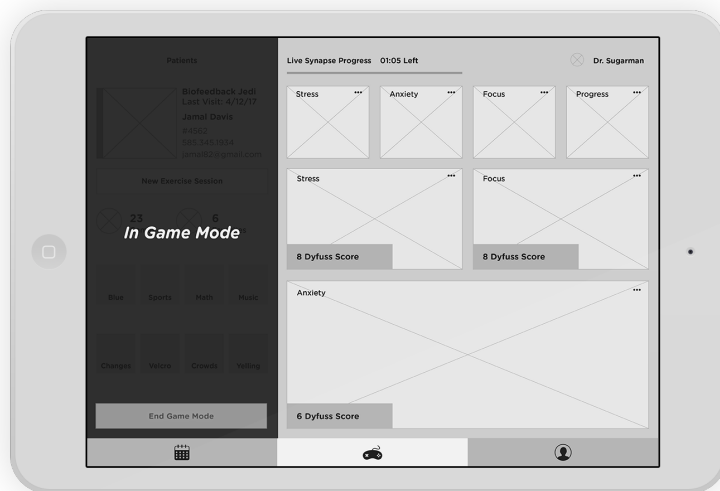


Figure 55. Doctor View: Biofeedback Exercise Screen - Live Biofeedback 1

## Mobile App Lo-Fidelity Wireframes Iteration 2

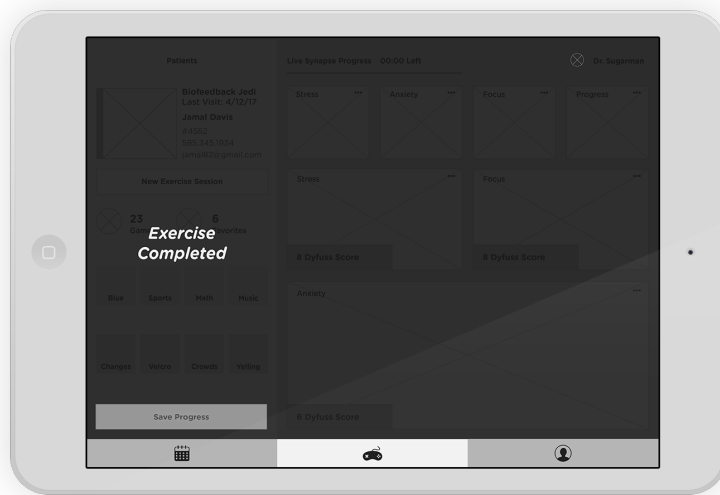


Figure 56. Doctor View: Biofeedback Exercise Screen - Live Biofeedback 2

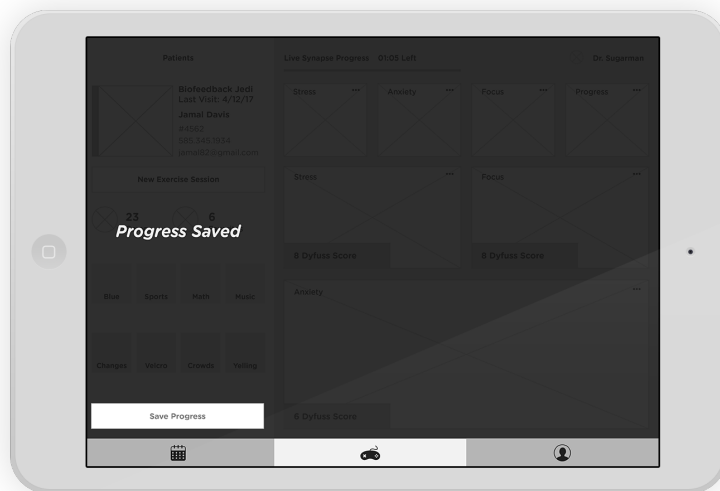


Figure 57. Doctor View: Biofeedback Exercise Screen - Live Biofeedback 3

## Mobile App Lo-Fidelity Wireframes Iteration 2

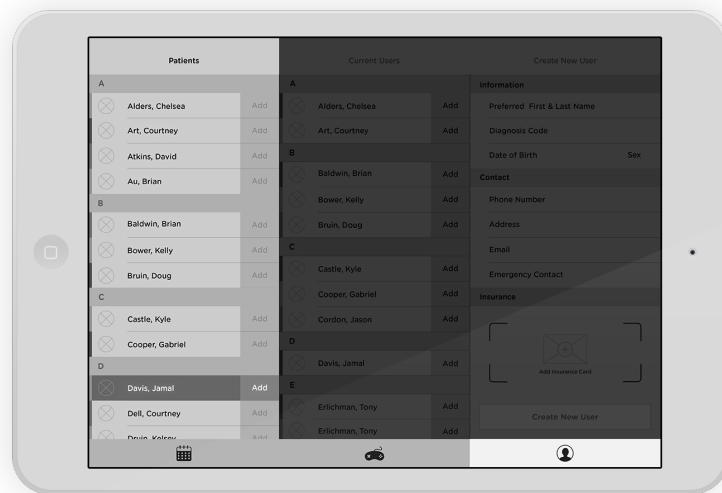


Figure 58. Doctor View: Patients Screen - Choose Patient

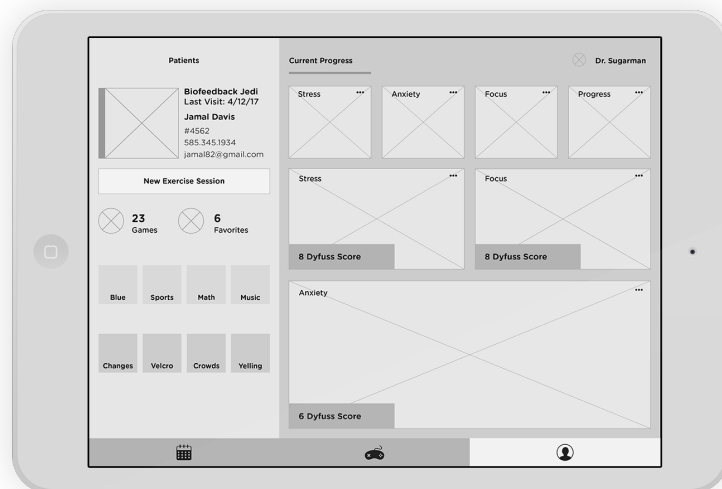


Figure 59. Doctor View: Patients Screen - Patient Profile

## Mobile App Lo-Fidelity Wireframes Iteration 2

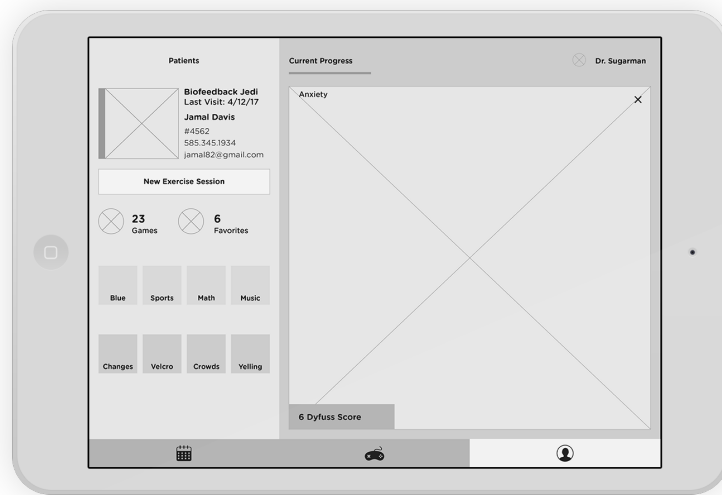


Figure 60. Doctor View: Patients Screen - Patient Profile, Anxiety Progress Zoomed View

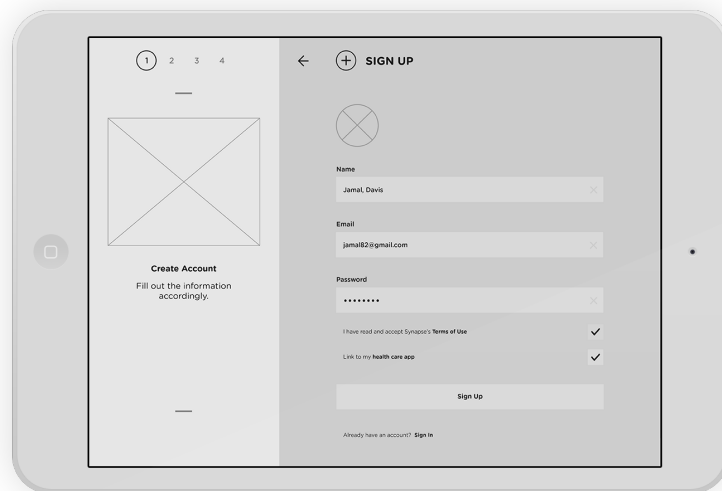


Figure 61. Patient View: Sign Up User Profile Information Feedback

## Mobile App Lo-Fidelity Wireframes Iteration 2

1 2 3 4

← + SIGN UP

Date of Birth MM DD YYYY Gender Male Female

Address

Email

Emergency Contact

First & Last Name

Telephone number including area code

Next

Already have an account? Sign In

Create Account

Fill out the information accordingly.

Figure 62. Patient View: Sign Up User Profile Information 2

1 2 3 4

← + SIGN UP

Date of Birth 04 12 2001 Gender Male Female

Address

5 Knickerbocker Rd, Pittsford, NY 14534

Email

585-245-1854

Emergency Contact

Anavhia Davis

585-329-5723

Next

Already have an account? Sign In

Create Account

Fill out the information accordingly.

Figure 63. Patient View: Sign Up User Profile Information 2 Feedback

## Mobile App Lo-Fidelity Wireframes Iteration 2

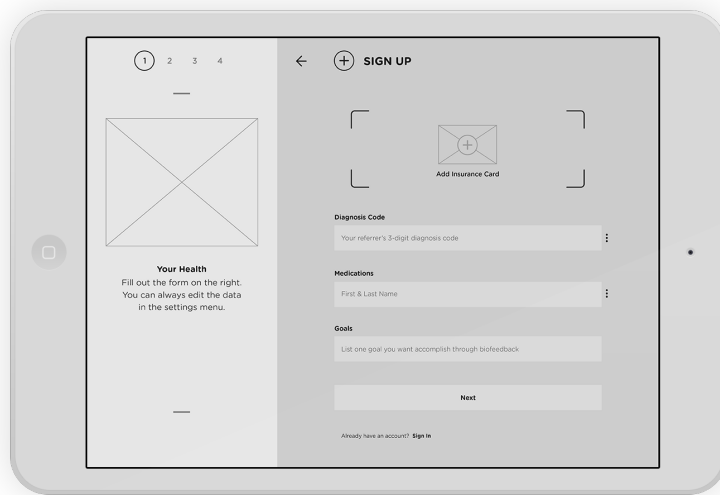


Figure 64. Patient View: Sign Up User Health Information

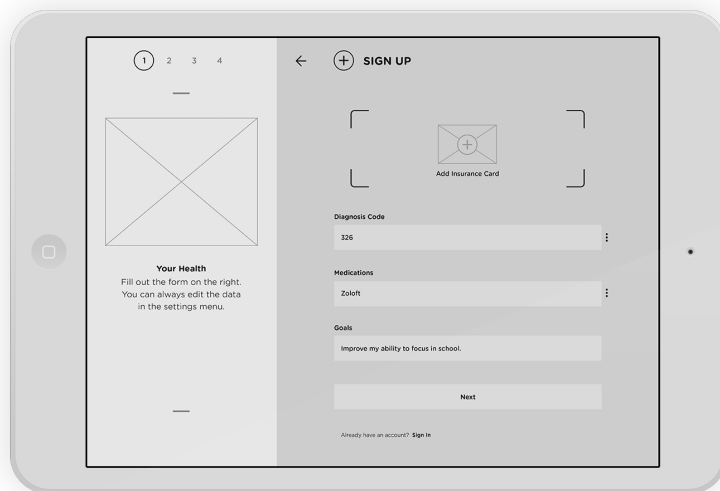


Figure 65. Patient View: Sign Up User Health Information Feedback

## Mobile App Lo-Fidelity Wireframes Iteration 2

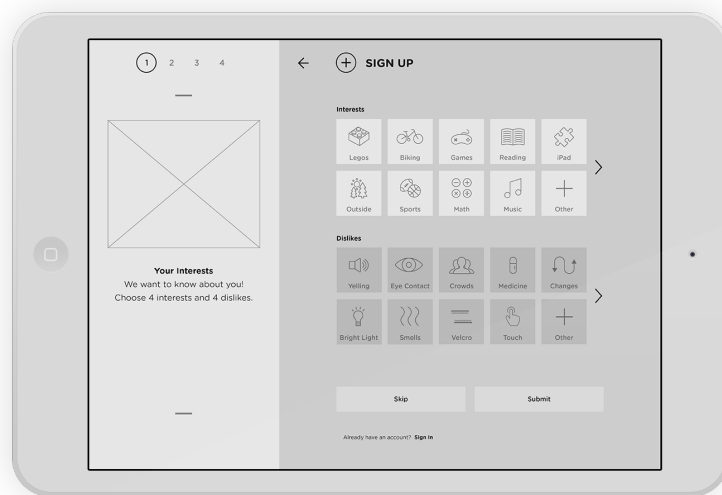


Figure 66. Patient View: Sign Up User Likes & Dislikes Input

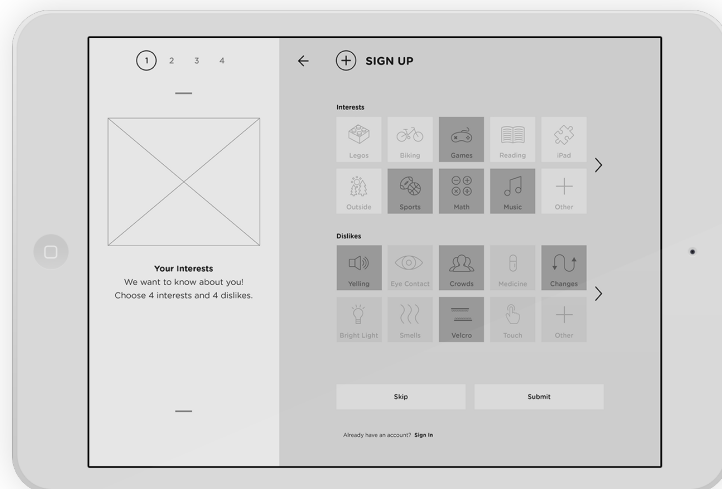


Figure 67. Patient View: Sign Up User Likes & Dislikes Input Feedback

## Mobile App Lo-Fidelity Wireframes Iteration 2

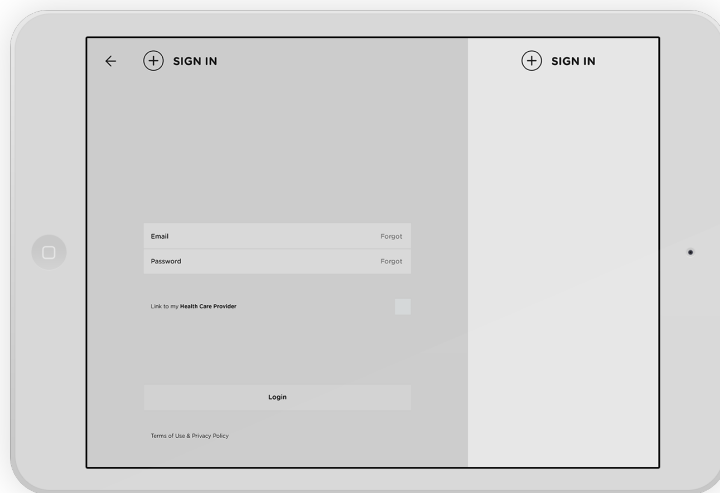


Figure 68. Patient View: Sign In

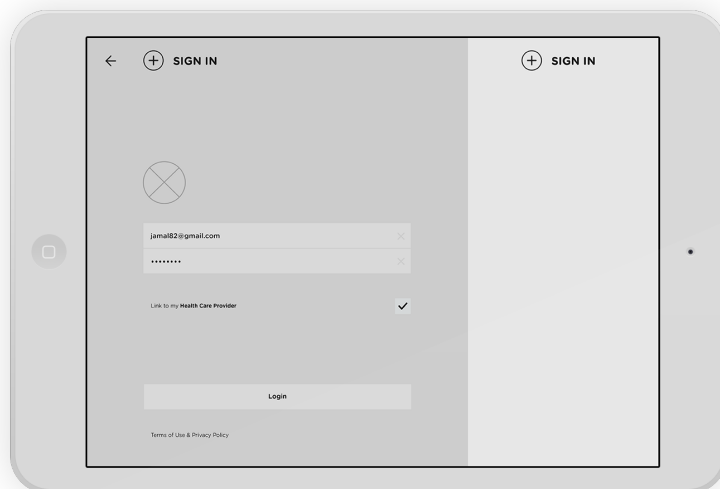


Figure 69. Patient View: Sign In Feedback



## Mobile App Lo-Fidelity Wireframes Iteration 2

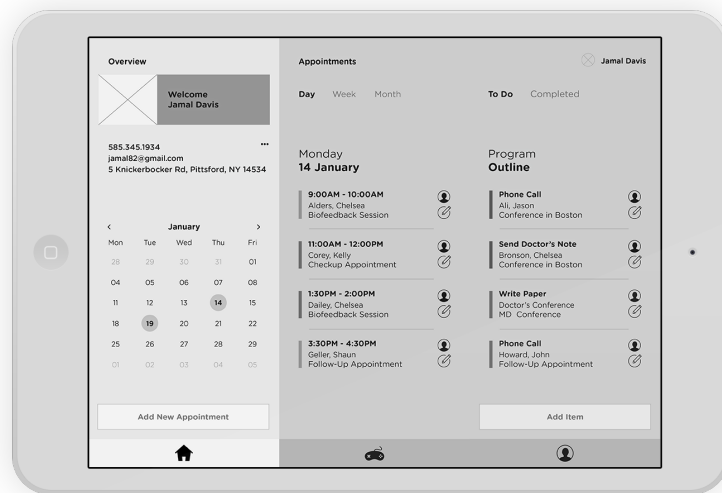


Figure 70. Patient View: Home Screen

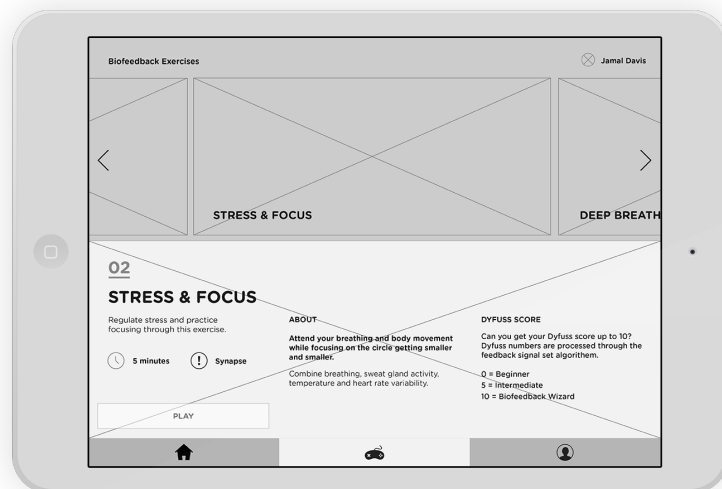


Figure 71. Patient View: Biofeedback Exercise Screen - Stress & Focus

## Mobile App Lo-Fidelity Wireframes Iteration 2

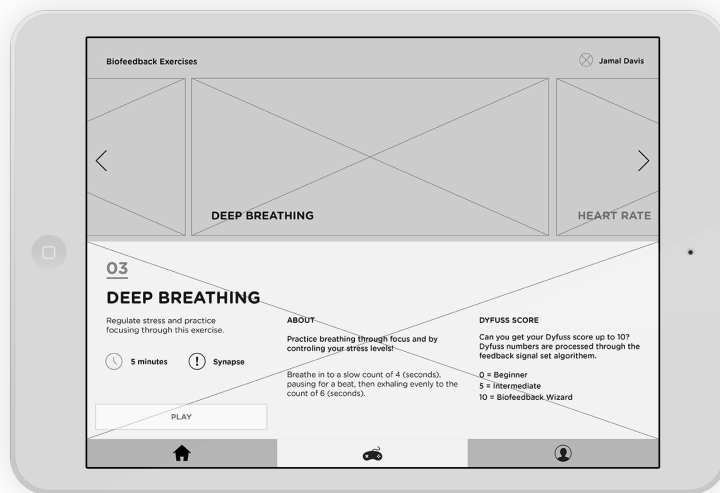


Figure 72. Patient View: Biofeedback Exercise Screen - Deep Breathing

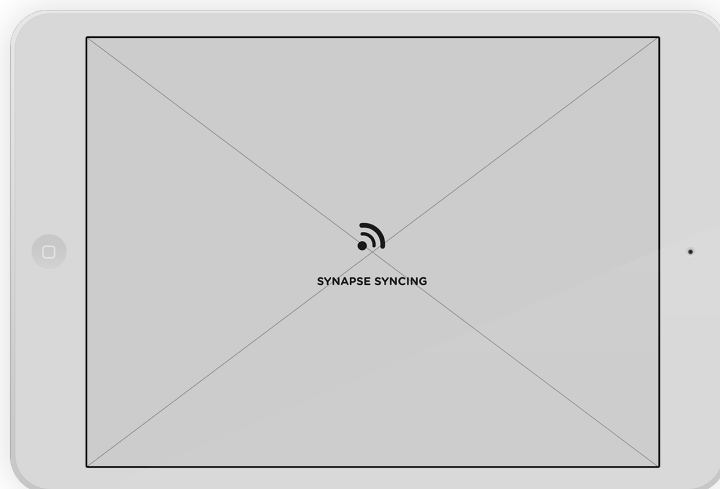


Figure 73. Patient View: Biofeedback Exercise Screen - SynApps Syncing

## Mobile App Lo-Fidelity Wireframes Iteration 2



Figure 74. Patient View: Biofeedback Exercise Screen - SynApps Synced



Figure 75. Patient View: Biofeedback Exercise Screen - Live Biofeedback

## Mobile App Lo-Fidelity Wireframes Iteration 2

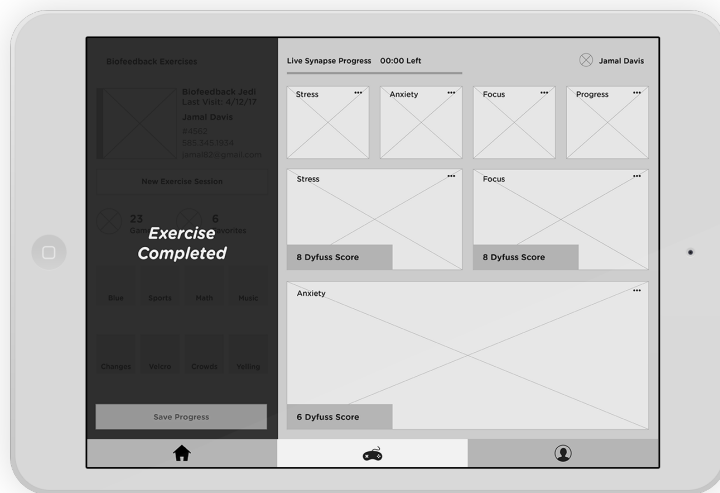


Figure 76. Patient View: Biofeedback Exercise Screen - Live Biofeedback 2

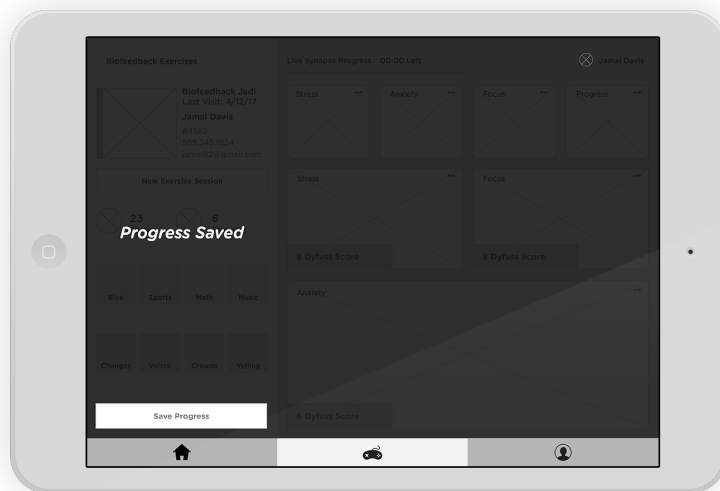


Figure 77. Patient View: Biofeedback Exercise Screen - Live Biofeedback 3

## Mobile App Lo-Fidelity Wireframes Iteration 2

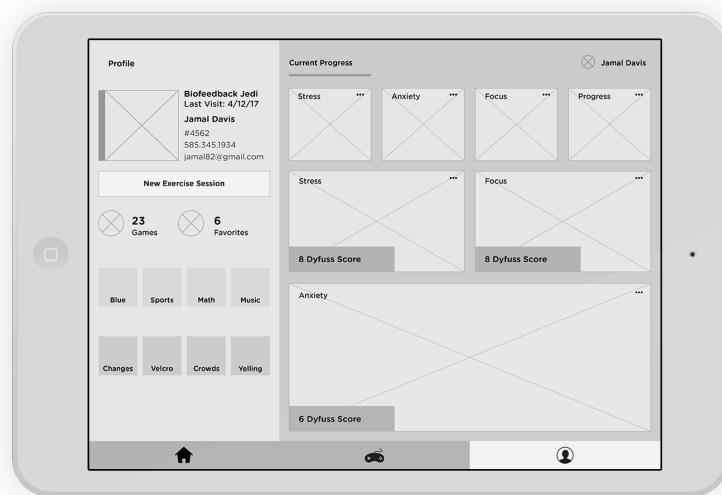


Figure 78. Patient View: Patient Account & Progress

## Mobile App Lo-Fidelity Iteration 2 Prototype

User testing was conducted with designers and topic professionals using a prototype of the lo fidelity wireframes in InVision (Figure 79).

The InVision prototype link is located here: <https://invis.io/E5BKZ16RB>

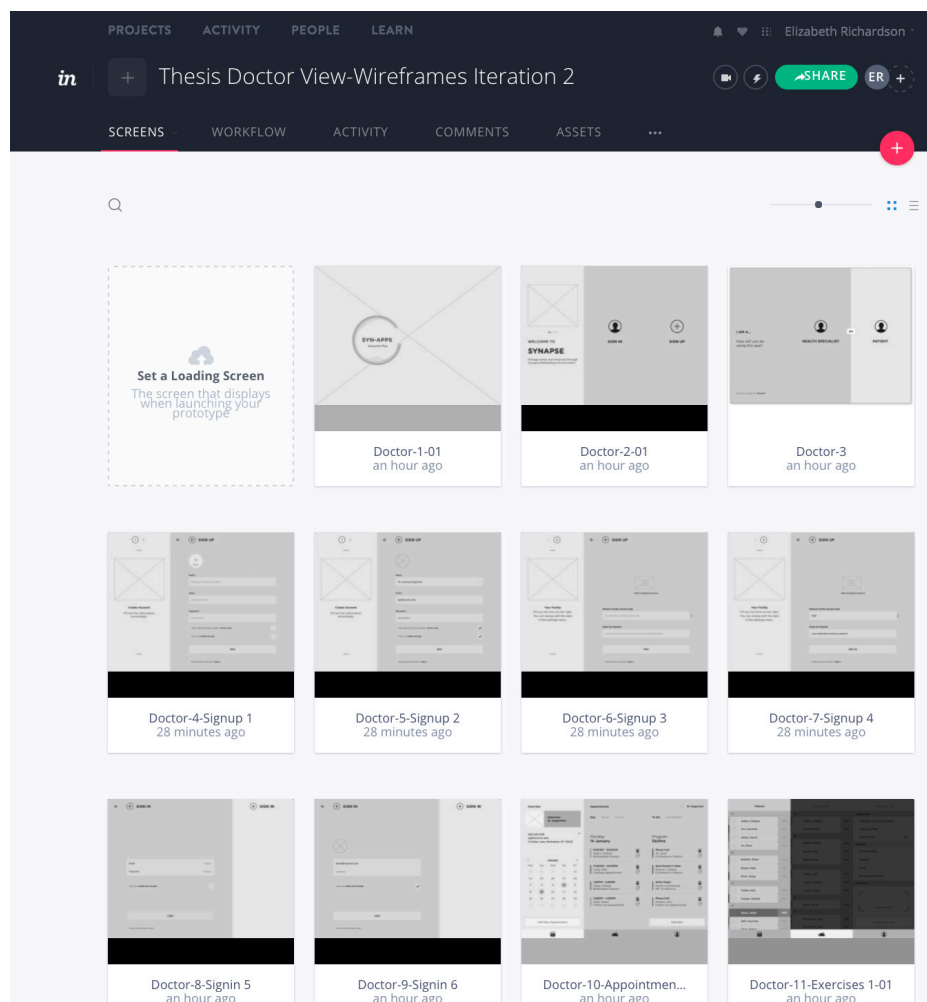


Figure 79. Mobile App Low Fidelity Iteration 2 Invision Prototype

## Mobile App Lo-Fidelity Wireframes Iteration 2

### User Scenario Testing

#### Testing & Results

**Task 1** = In doctor view, add Jamal Davis to a deep breathing biofeedback exercise.

**Task 2** = In doctor view, review Jamal Davis' anxiety levels.

**Task 3** = In patient view, review your biofeedback exercise progress.

**Task 4** = In patient view, save the progress of a deep breathing biofeedback exercise.

Participant	Task 1	Task 2	Task 3	Task 4
1	Success	Success	Success	Success
2	Success	Success	Success	Fail
3	Success	Success	Success	Success
4	Success	Fail	Success	Success
5	Success	Success	Success	Success
6	Success	Success	Success	Fail
7	Success	Success	Success	Success
8	Success	Success	Success	Success
9	Fail	Success	Success	Success
10	Success	Success	Success	Success
Success	90%	90%	100%	80%

Figure 80. User Scenario Wireframe Iteration 2 Usability Testing

## Mobile App Lo-Fidelity Wireframes Iteration 2 User Testing

### Feedback Wireframes Iteration 2

Based on user feedback from wireframes iteration 1, a second iteration of low-fidelity wireframes were developed (Figures 40-77). Based on user feedback from iteration 1, both a doctor and patient view was created for the second iteration. The purpose of this was to highlight the different wants and needs of these users. User feedback on wireframes iteration 2 was received through a combination of various discussions with additional designers and topic professionals.

Second iteration of wireframes blocking out main content areas.

### Doctor View

- Doctor Appointments
- Biofeedback Exercise
- Patients

### Patient View

- Patient Home
- Biofeedback Exercise
- Patient Account & Progress

### Considerations



- Create a simple, 3 column structure to be utilized throughout the app.



- Simplify complex health information.



- Visual and informational heirarchy.



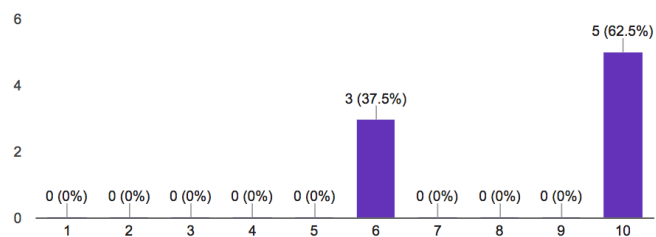
- The ability to track progress, save progress, and see patient's live biofeedback progress while in "game mode."



## Mobile Application Iteration 2 User Testing 1

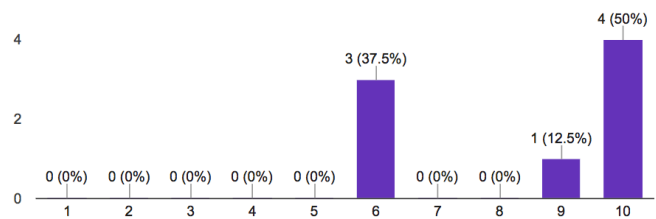
The type is legible and effective.

8 responses



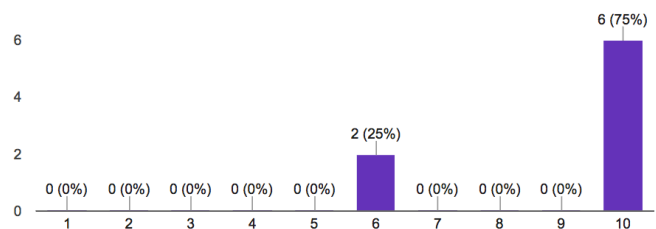
The buttons are useful.

8 responses



The app is easy to navigate and content was organized.

8 responses



## Color Association User Testing

What emotions do you associate with cool colors? (Blues, purples, greens)

8 responses

Calm
Calm
Calm, happy.
Soothing, cooling sensations. Serenity, peace of mind.
Makes me feel really calm and relaxed.
Calming, relaxing, sleepiness.
Calming, calmness
Calm, relaxing.

What emotions do you associate with warm colors? (Reds, oranges, pinks)

8 responses

Happy.
Anger, agitation, excitement.
Anger
Anxious
I think of anger and frustration.
Awake, blinding, anger.
Anger, violence, etc.
Danger, warning

Figure 81. Color Association User Testing

## Mobile Application Visual Style User Testing

### Options for Visual Style

User testing on color associations (Figure 81) informed the final color palette. Varied styles of layout (Figures 82-84), interactions, graphics, type sizes, and levels of hierarchy were explored to gauge user preference through user testing. Users were asked which versions they preferred, helping drive final visual design decisions. User testing found that users preferred visual style 3, a dark blue color palette (Figure 85).

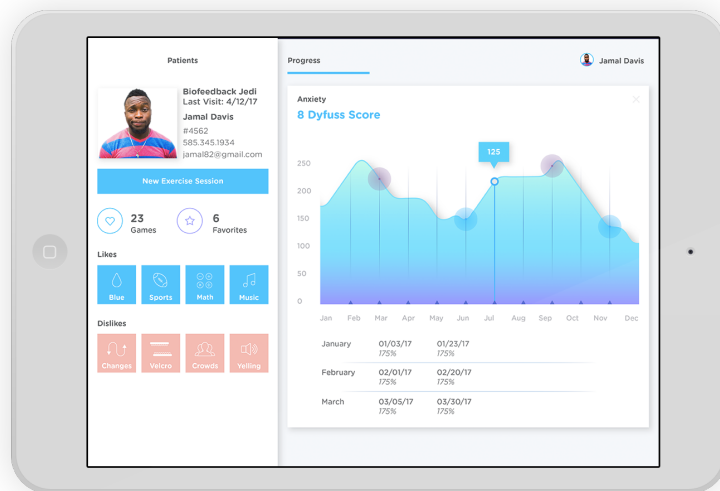


Figure 82. Visual Style 1

## Mobile Application Visual Style User Testing

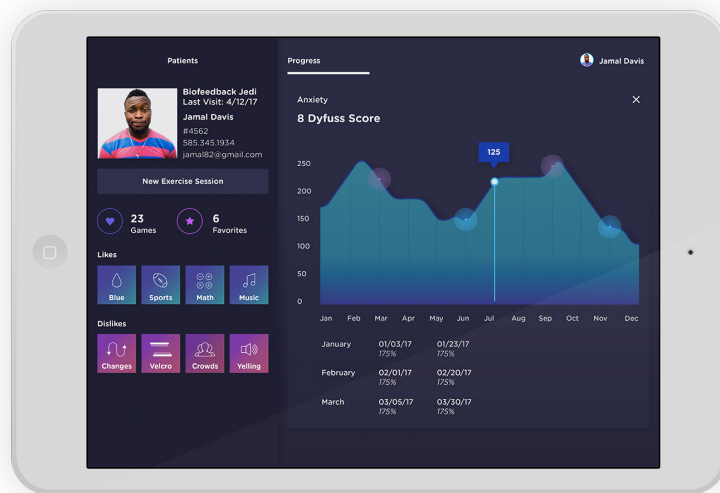


Figure 83. Visual Style 2

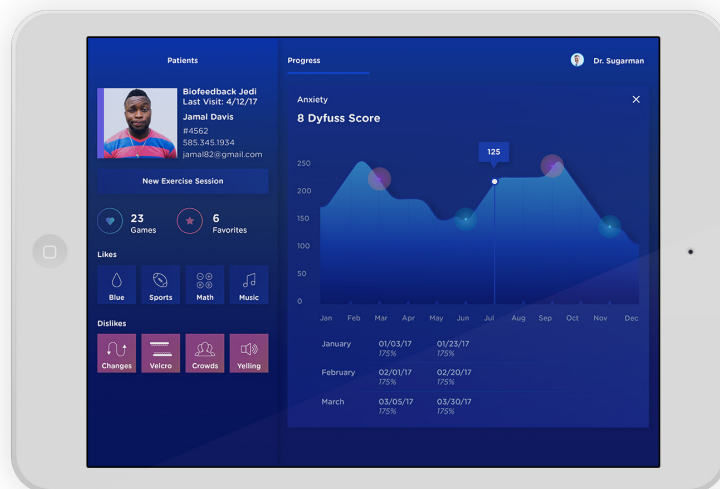


Figure 84. Visual Style 3

## Mobile Application Visual Style User Testing

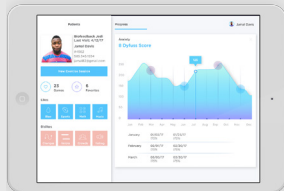
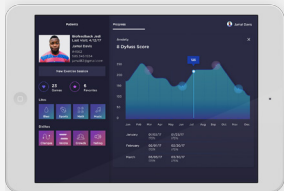
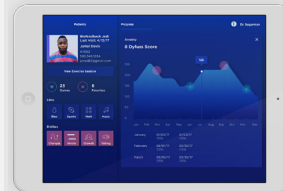
Visual Style User Testing				
				
	Visual Style 1	Visual Style 2	Visual Style 3	
1. Which visual style provides a more soothing and calming experience.	2	3	5	
2. Which visual style reminds you of a health application.	5	1	4	
3. Which visual style emphasizes important features on the screen.	3	3	4	
4. Which visual style would most likely encourage you to return to the app?	4	2	4	
Other Comments	User 2: There is nice negative space. User 4: The important features pop User 8: IWish there was more color.	User 4: I don't like this color palette. User 6: The black is too dark for a health app. User 8: This doesn't remind me of health at all and is not relaxing because of the black.	User 1: The shades of blue are calming and nice. I would like to see these colors in a health app. User 3: Colors pop in this visual style. User 5: I like the color combinations.	

Figure 85. Visual Style Usability Testing Results

## Visual Style

The visual style needed to be minimal in order to clearly convey complex information regarding biofeedback to users. Three areas were of importance:

- 1.The importance of doctors recognizing users current level of biofeedback and the ability to review and edit appointments.
2. The ability to quickly understand and see a user's current biofeedback while in a session, in addition to reviewing progress over time.
- 3.The importance of clearly communicating goals and requirements of the biofeedback exercise while in a session.

## Color Palette

The main color palette was chosen based on user testing (Figure 86). User testing showed that users positively responded to cool colors causing the majority of the color palette to be comprised of cool colors with warm accent colors to draw the user's attention to important features and functions. The prominence of cool colors aims to soothe and calm users.

*Mobile application and biofeedback exercise color palette*



**Figure 86.** Color Palette

## **Branding**

### **Name**

Synapse - syn·apse /'si-naps/ noun, The point at which a nervous impulse passes from one neuron to another. (Merriam-Webster Dictionary 2017).

### **Mission**

To offer a tool to help alleviate symptoms of autism. Cultivating a sense of control over mind and body for young adults with autism.

### **Differentiation**

- Provide innovative and engaging ways to interact with biofeedback exercise
- Build a greater understanding of progress through biofeedback exercise
- Offer biofeedback treatment for young adults with autism
- Improve current biofeedback system

### **Tagline**

"Create, Connect, and Control"

## Product Name Ideation - Word Bank

Achieve	Home	Plastic
Brainwaves	Input	Processing
Care	Interaction	Social
Cerebral	Learning	Solution
Comfort	Life	Special
Connect	Links	Stimulation
Development	Malleable	Synapses
Electric	Mu waves	Therapy
Exercises	Neuro	Treatment
Experimental	Neuroplasticity	Unify
Feedback	Physiological	Yoga
Goals		



## **Product Name Ideation**

### **Feedback of favorite names**

Allo

isotonos

Me2Mu

Synapse

Synergy

## Typography

Type choices were made based on the target audience and the importance for legibility. The type choice needed to be attractive to both younger audiences and medical professionals. The goal was to have a human aspect to it with a modern, chic approach. As a result, Gotham Rounded was chosen for this reason in addition to accessibility for digital/screen use on mobile applications.

Gotham Rounded Book

AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQqRrSsTtUuVvWwXxYyZz  
1234567890

*Gotham Rounded Book Italic*

*AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQqRrSsTtUuVvWwXxYyZz  
1234567890*

Gotham Rounded Medium

AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQqRrSsTtUuVvWwXxYyZz  
1234567890

*Gotham Rounded Medium Italic*

*AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQqRrSsTtUuVvWwXxYyZz  
1234567890*

Gotham Rounded Bold

AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQqRrSsTtUuVvWwXxYyZz  
1234567890

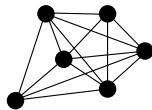
***Gotham Rounded Bold Italic******AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQqRrSsTtUuVvWwXxYyZz******1234567890*****Final Logotype**

The logotype needed to be attractive to both younger audiences and medical professionals. The goal was for the type to be clean and modern, appealing to the digital approach, while having a touch of humanism, to welcome and engage users. Refined explorations (Figure 87) informed the final logotype (Figure 88).

**Initial Sketches**

Concept directions were explored to express connection, technology, and humanism (Figure 87).

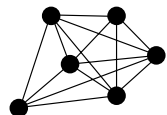
### Refined Explorations



# Synapse

**Figure 87.** Color Palette

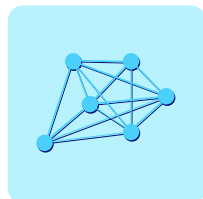
### Final Logotype



# SynApps

**Figure 88.** Color Palette

### Application Icon



# SynApps

## Iconography

### Refined Sketches

Icons representing the following actions were explored:

- Home
- Calendar
- Account
- Patients
- Progress
- Biofeedback Exercise
- Settings

## Iconography

### Final Icon Set

#### TOP TOOLBAR



#### SIGN ON/SIGN UP SCREEN



#### PATIENT USER BOTTOM TOOLBAR



#### DOCTOR USER BOTTOM TOOLBAR



#### SECONDARY SUPPORT ICONS



## Mobile Application Final Screen Designs

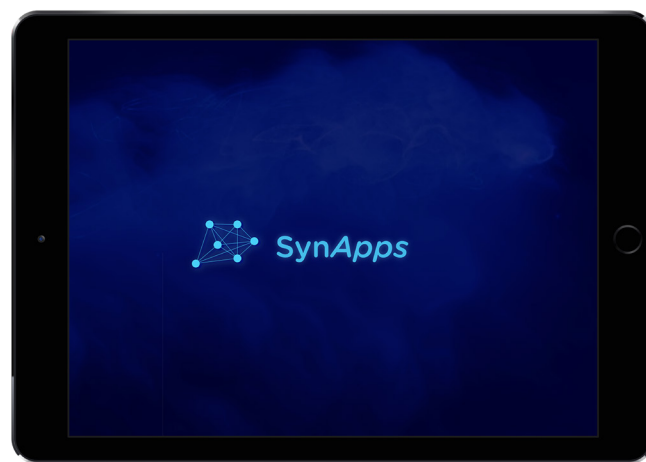


Figure 87. Doctor View: Splashscreen

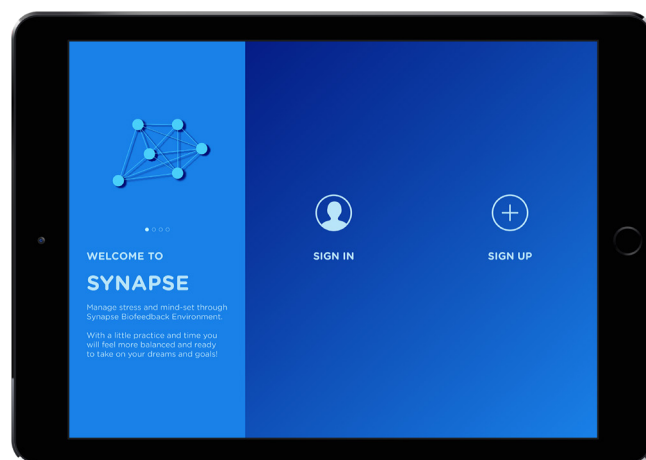


Figure 88. Doctor View: Sign In or Sign up Screen

## Mobile Application Final Screen Designs

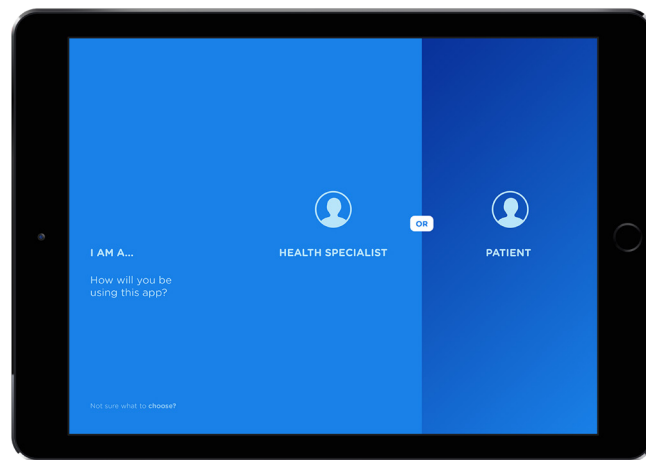


Figure 89. Doctor View: Sign Up - User Profile

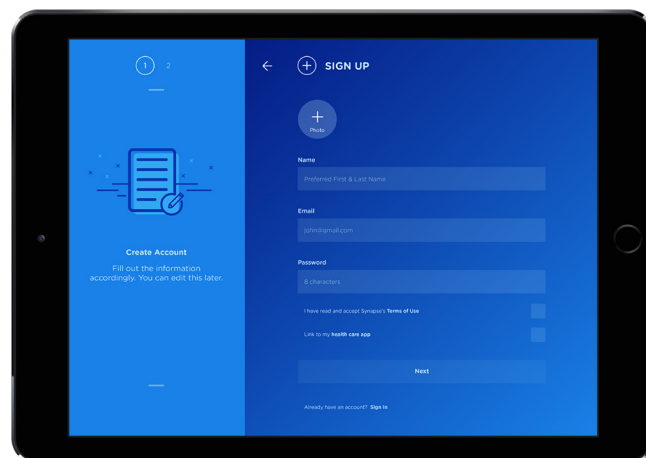


Figure 90. Doctor View: Sign Up - User Profile Information



## Mobile Application Final Screen Designs

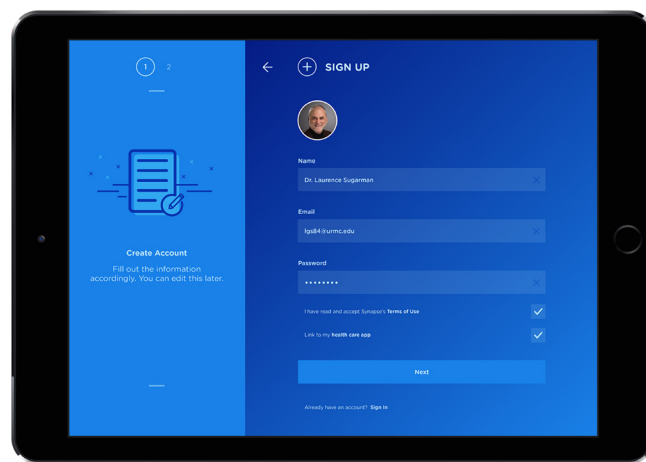


Figure 91. Doctor View: Sign Up - User Profile Information

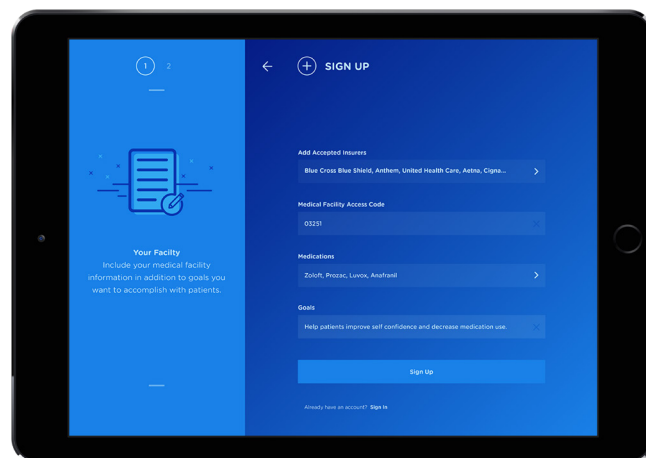


Figure 92. Doctor View: Sign Up - Medical Facility Information

## Mobile Application Final Screen Designs

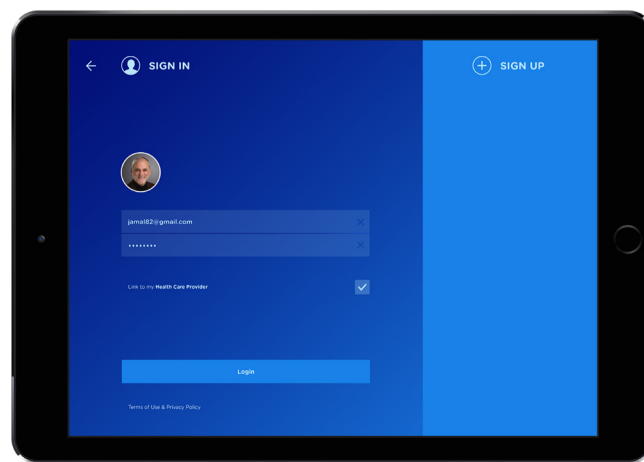


Figure 93. Doctor View: Sign In

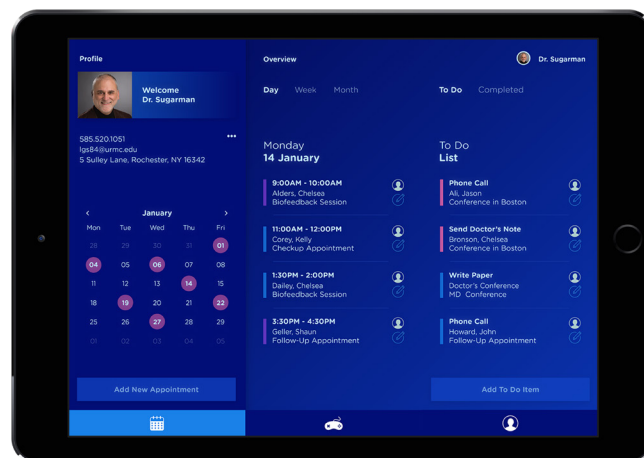


Figure 94. Doctor View: Appointments

## Mobile Application Final Screen Designs

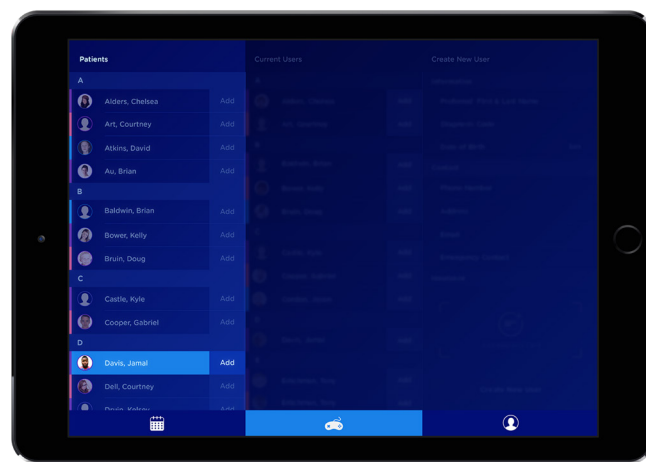


Figure 95. Doctor View: Biofeedback Exercises - Add Patient

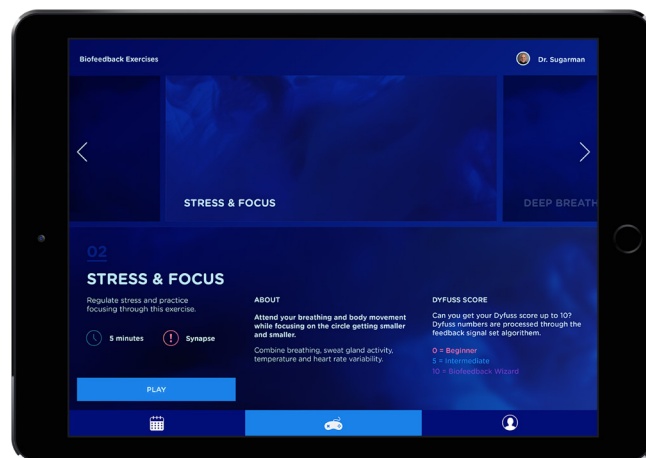


Figure 96. Doctor View: Biofeedback Exercises - Stress & Focus

## Mobile Application Final Screen Designs

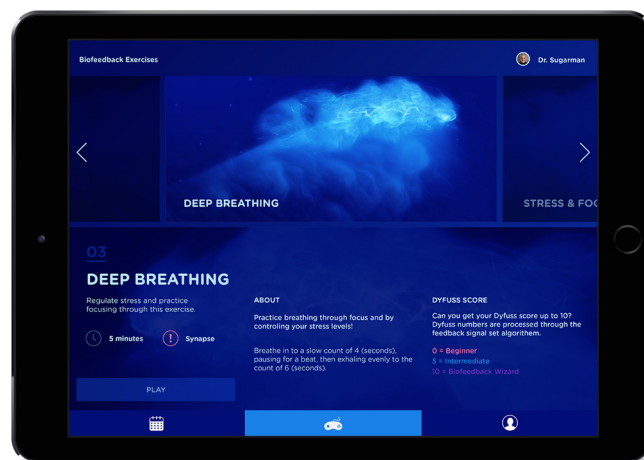


Figure 97. Doctor View: Biofeedback Exercises - Breathing Exercise

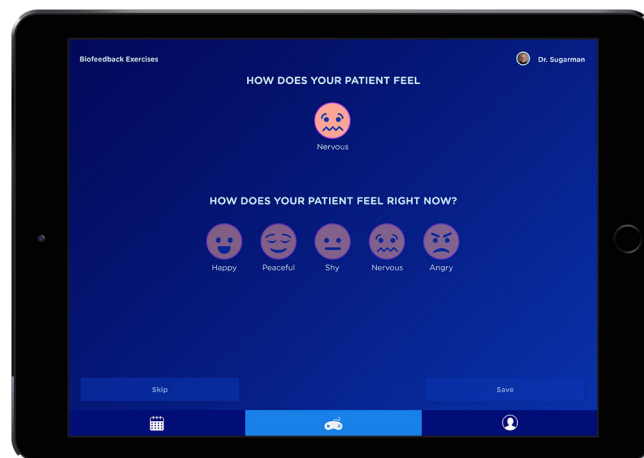


Figure 98. Doctor View: Biofeedback Exercise - User Mood

## Mobile Application Final Screen Designs

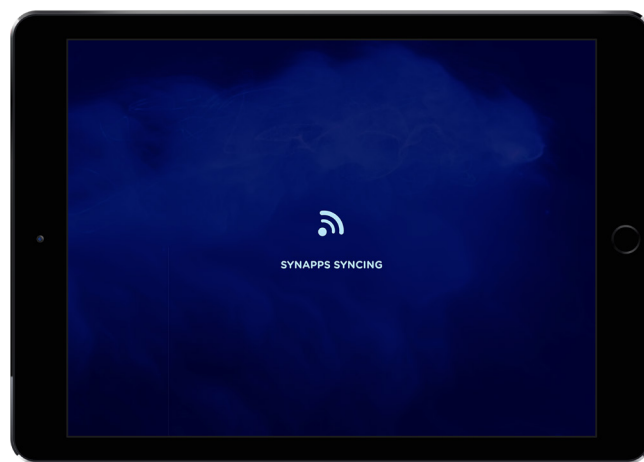


Figure 99. Doctor View: Biofeedback Exercise Page - SynApps Syncing

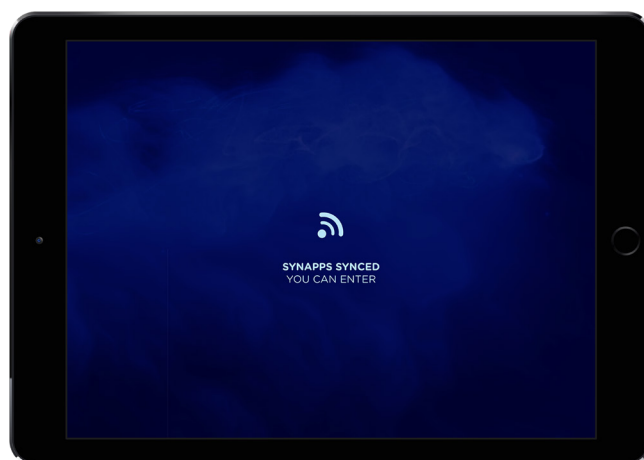


Figure 100. Doctor View: Biofeedback Exercise Page - SynApps Synced

## Mobile Application Final Screen Designs

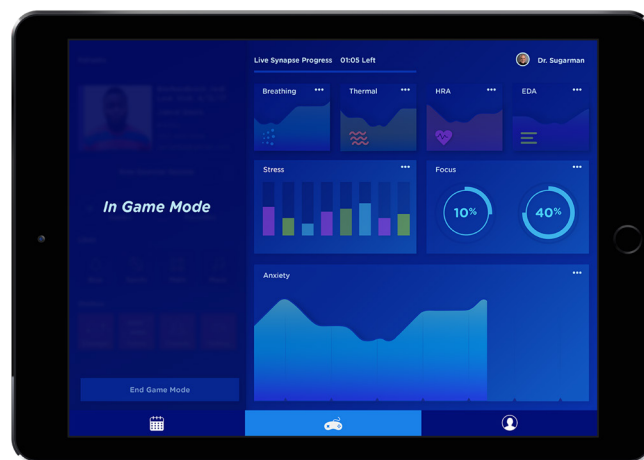


Figure 101. Doctor View: Biofeedback Exercise - Game Mode

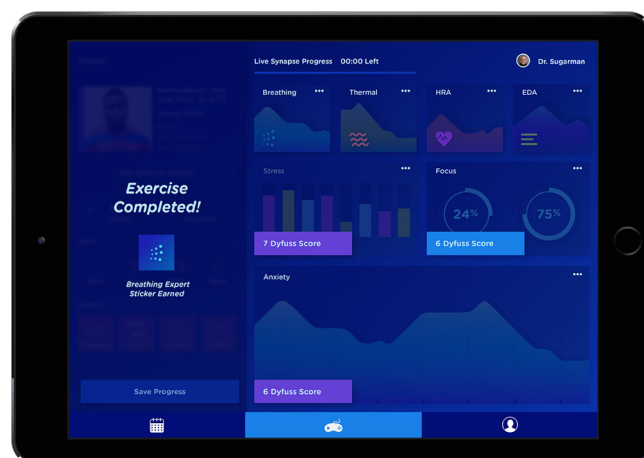


Figure 102. Doctor View: Biofeedback Exercise - Exercise Completed

## Mobile Application Final Screen Designs

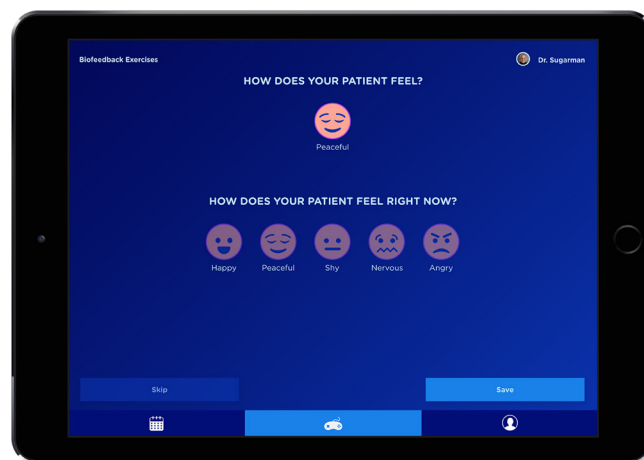


Figure 103. Doctor View: Biofeedback Exercise - User Mood

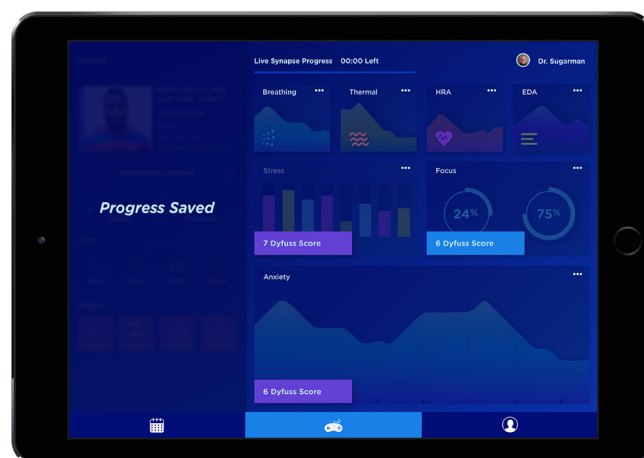


Figure 104. Doctor View: Biofeedback Exercise Page - Progress Saved

## Mobile Application Final Screen Designs

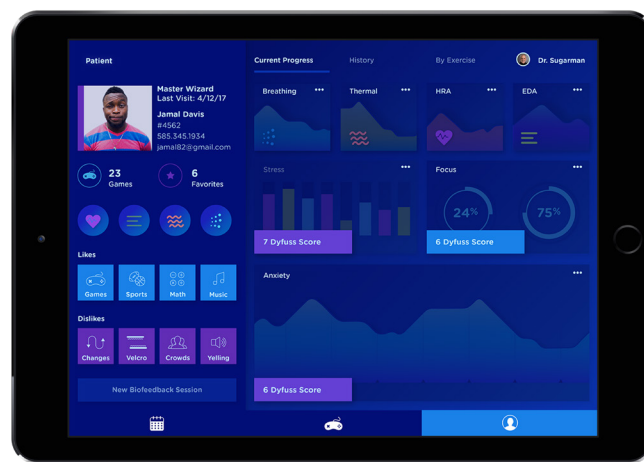


Figure 105. Doctor View: Patient Profile



Figure 106. Doctor View: Patient Profile - Anxiety Graph Zoomed



## Mobile Application Final Screen Designs

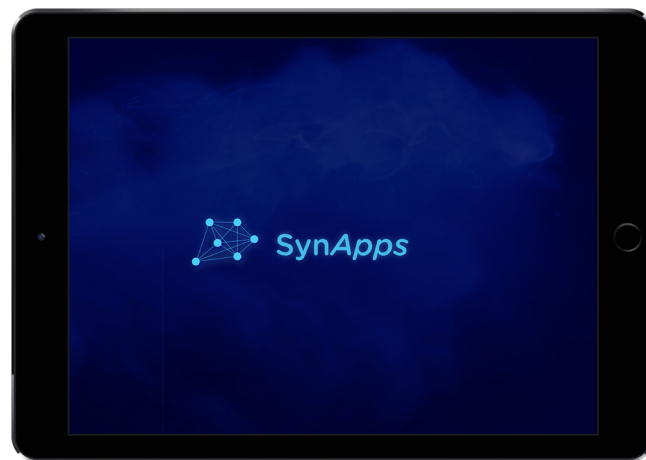


Figure 107. Patient View: Splashscreen

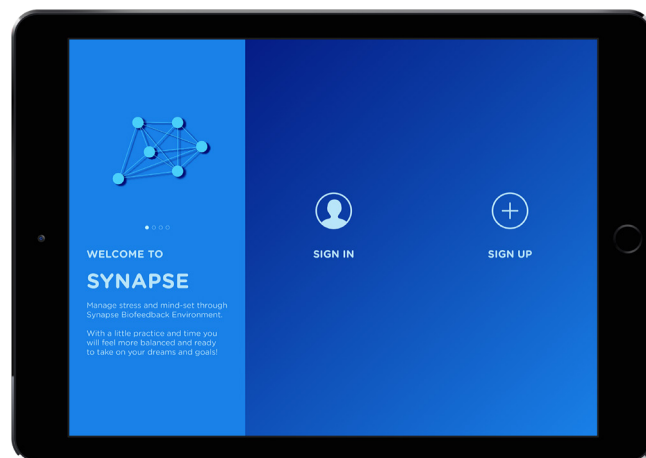


Figure 108. Patient View: Sign In or Sign Up

## Mobile Application Final Screen Designs

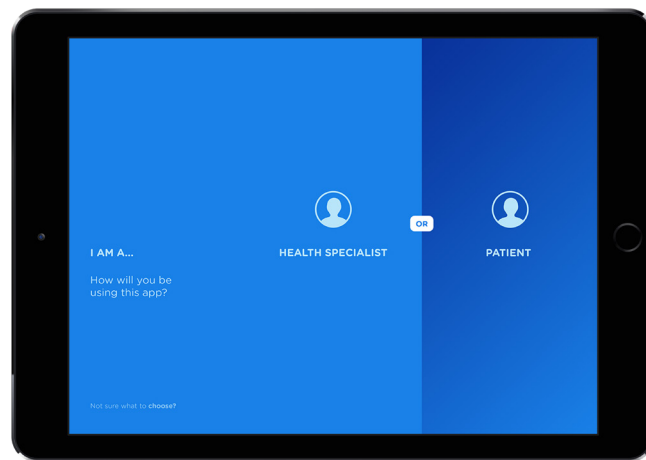


Figure 109. Patient View: Sign Up - User Profile

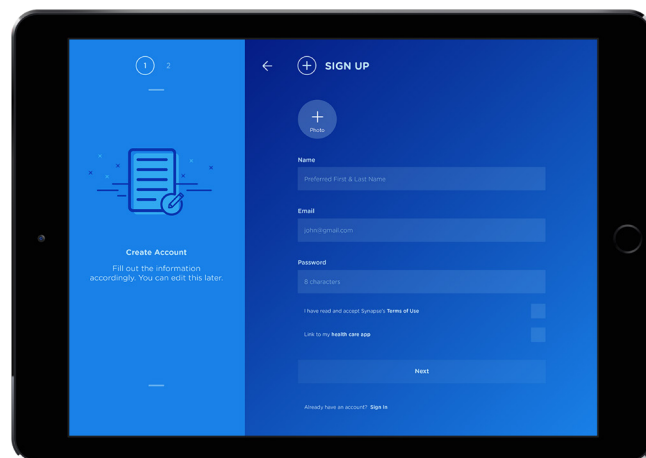


Figure 110. Patient View: Sign Up - Personal Information

## Mobile Application Final Screen Designs

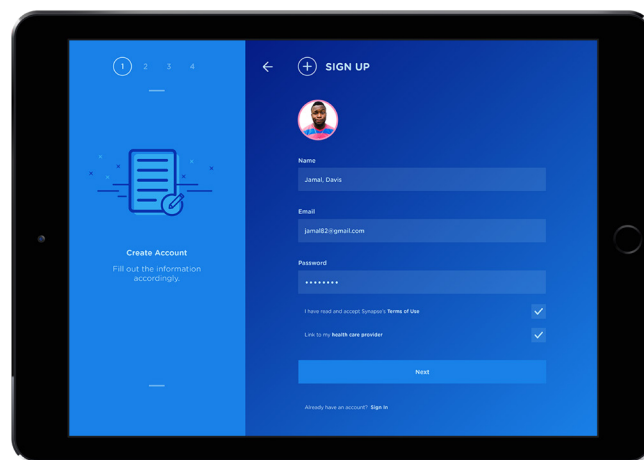


Figure 111. Patient View: Sign Up - Personal Information Feedback

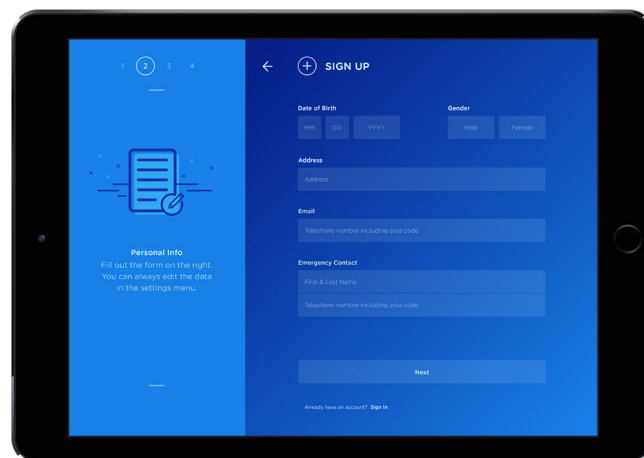


Figure 112. Patient View: Patient View: Sign Up - User Profile

## Mobile Application Final Screen Designs

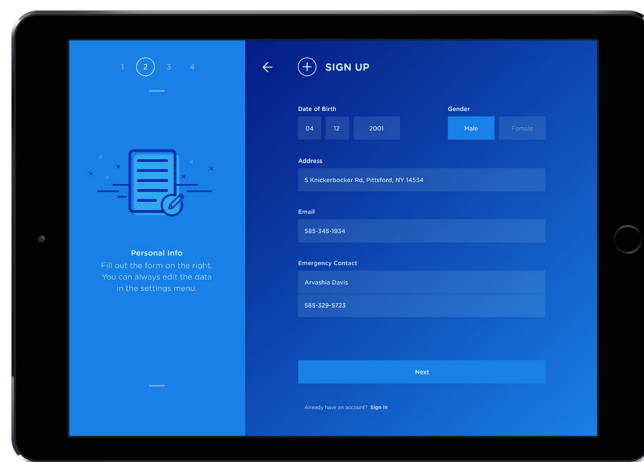


Figure 113. Patient View: Patient View: Sign Up - User Profile Feedback

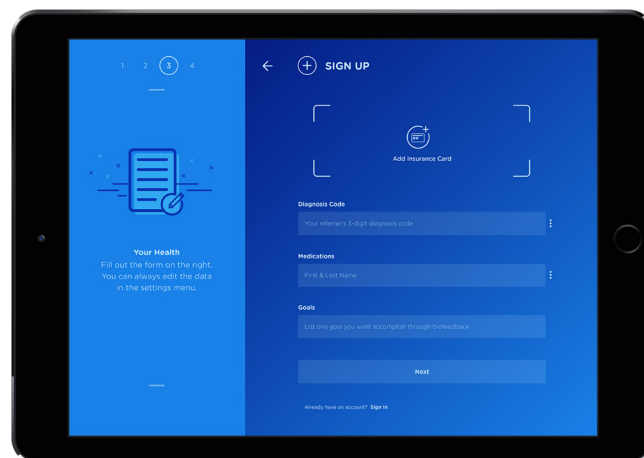


Figure 114. Patient View: Sign Up - Medical Information

## Mobile Application Final Screen Designs

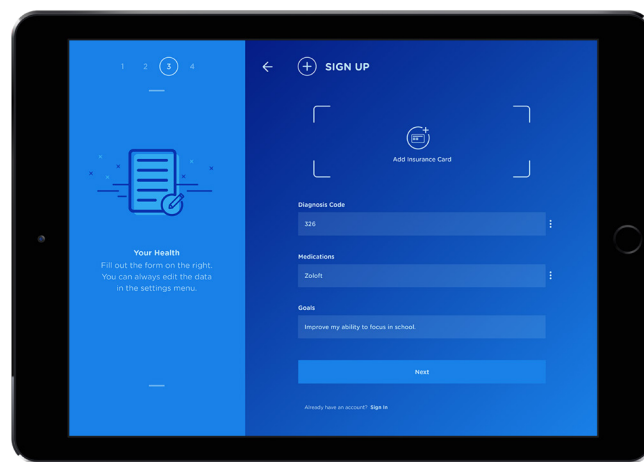


Figure 115. Patient View: Sign Up - Medical Information Feedback

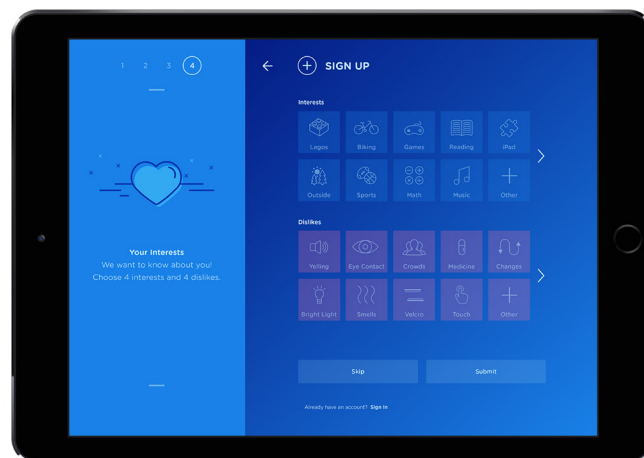


Figure 116. Patient View: Sign Up - Likes & Dislikes

## Mobile Application Final Screen Designs

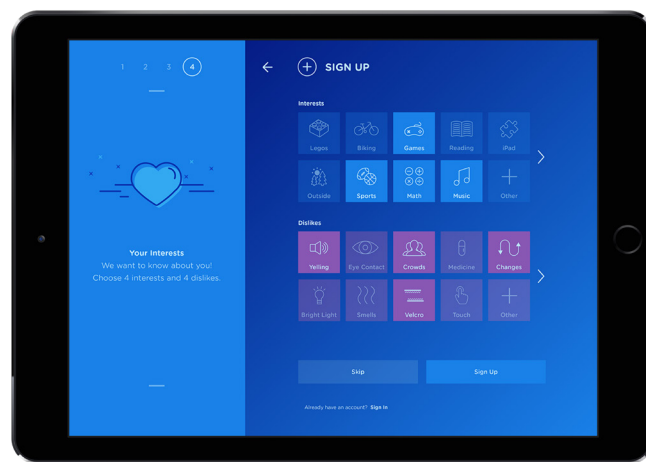


Figure 117. Patient View: Sign Up - Likes & Dislikes Feedback

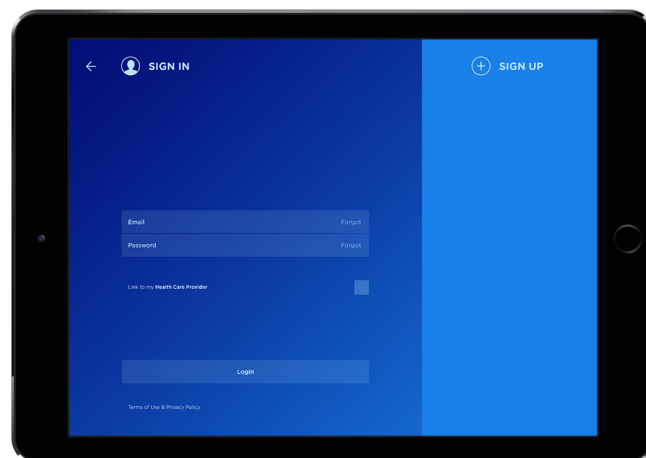


Figure 118. Patient View: Sign In

## Mobile Application Final Screen Designs

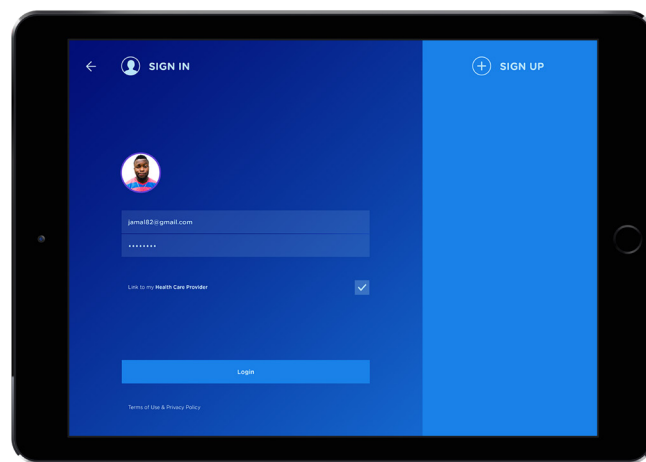


Figure 119. Patient View: Sign In Feedback

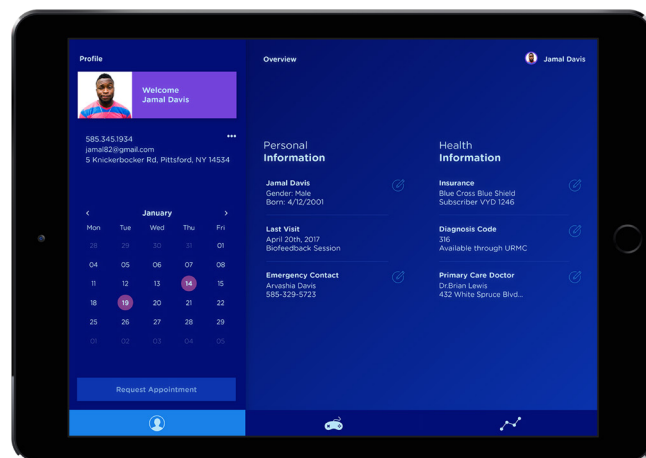


Figure 120. Patient View: Account

## Mobile Application Final Screen Designs

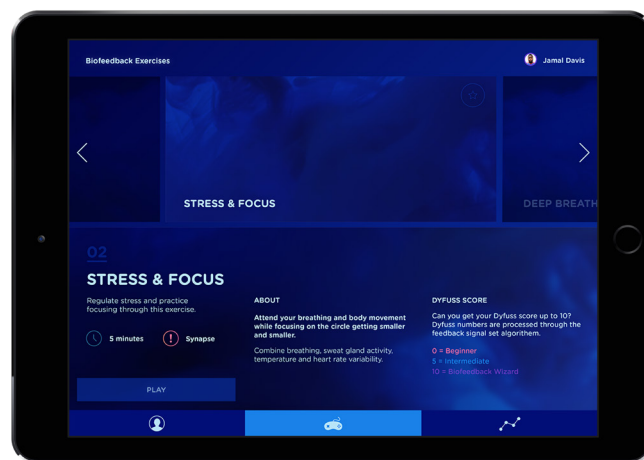


Figure 121. Patient View: Biofeedback Exercises - Stress & Focus

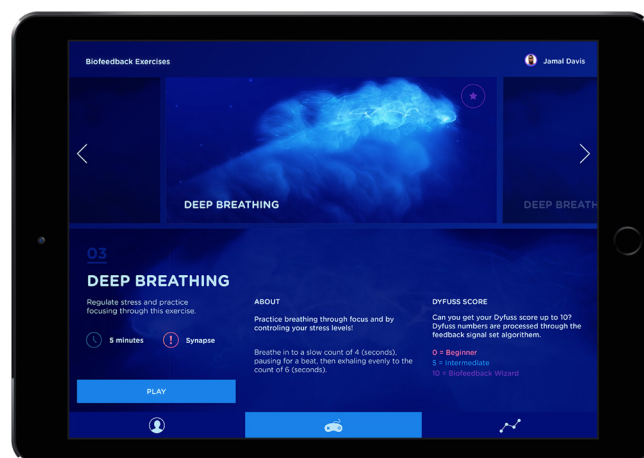


Figure 122. Patient View: Biofeedback Exercises - Breathing Exercise



## Mobile Application Final Screen Designs

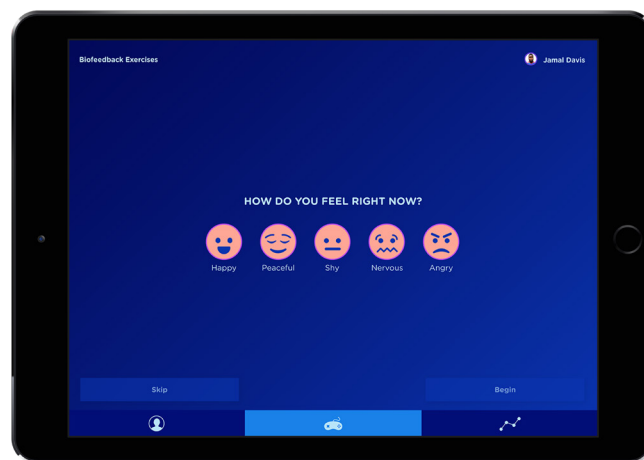


Figure 123. Patient View: Biofeedback Exercises - Patient Mood 1

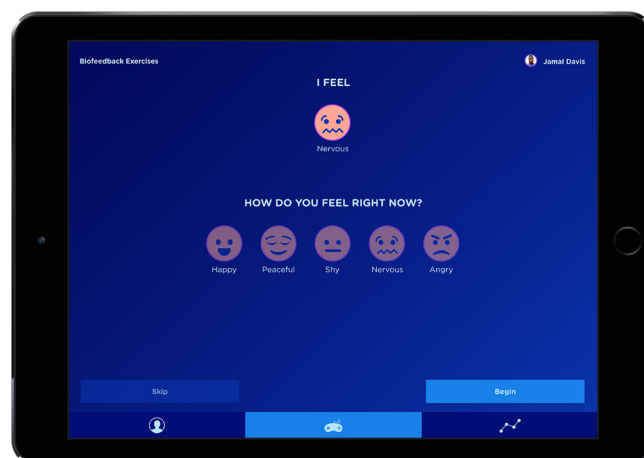


Figure 124. Patient View: Biofeedback Exercises - Patient Mood 1 Feedback

## Mobile Application Final Screen Designs

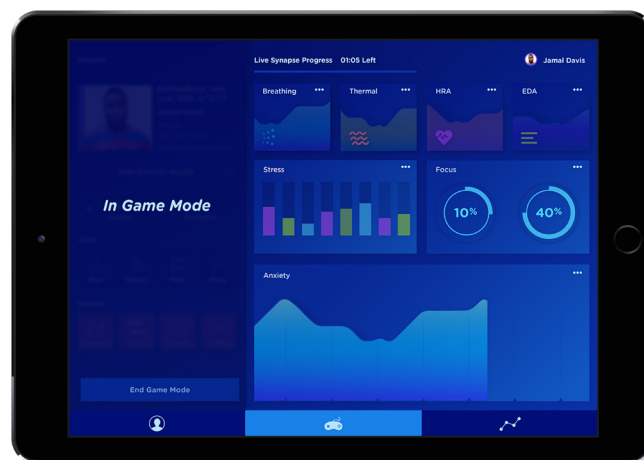


Figure 125. Patient View: Biofeedback Exercises Screen - In Game Mode

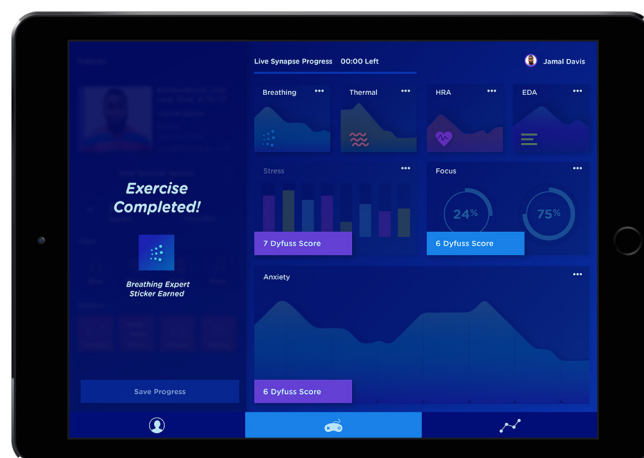


Figure 126. Patient View: Biofeedback Exercises Screen - Exercise Completed

## Mobile Application Final Screen Designs

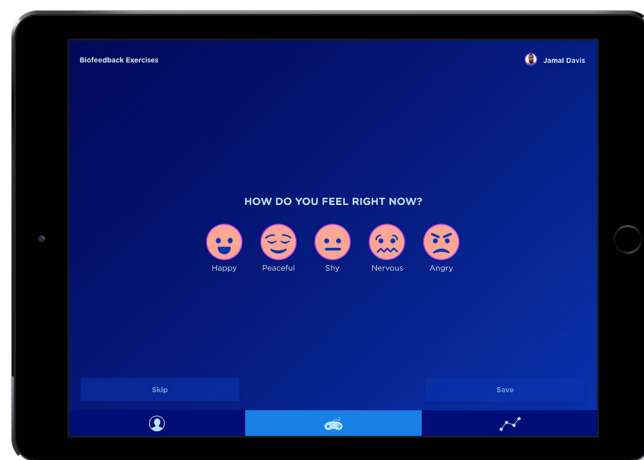


Figure 127. Patient View: Biofeedback Exercises - Patient Mood 2

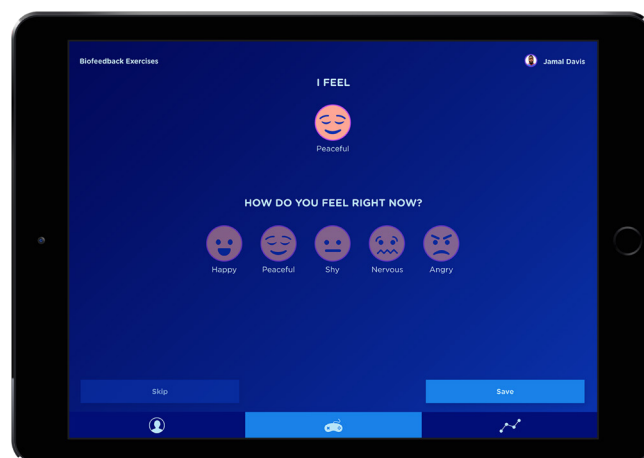


Figure 128. Patient View: Biofeedback Exercises - Patient Mood 2 Feedback

## Mobile Application Final Screen Designs

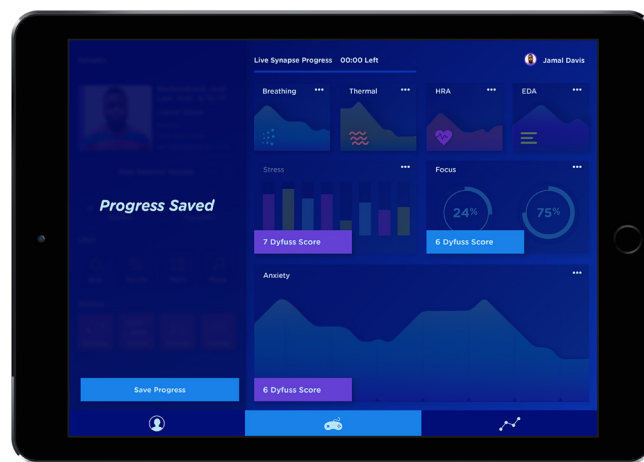


Figure 129. Patient View: Biofeedback Exercises Screen - Progress Saved

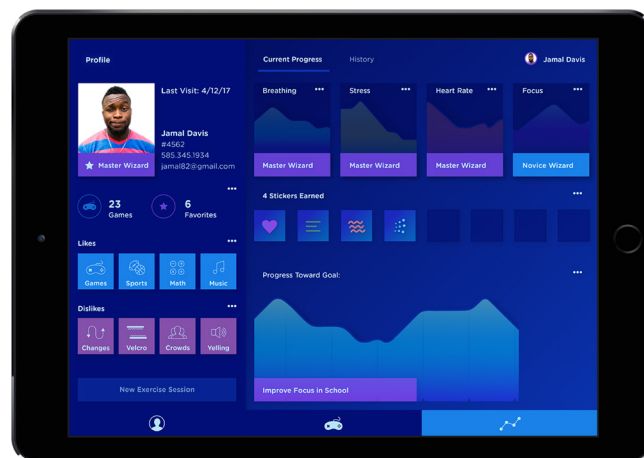


Figure 130. Patient View: Progress

## Mobile Application Final Screen Designs

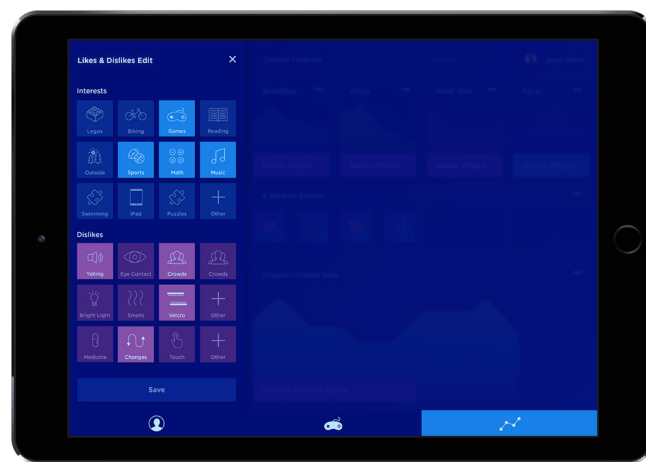


Figure 131. Patient View: Progress - Likes & Dislikes Edit

## Mobile Application Final Screens User Testing 1

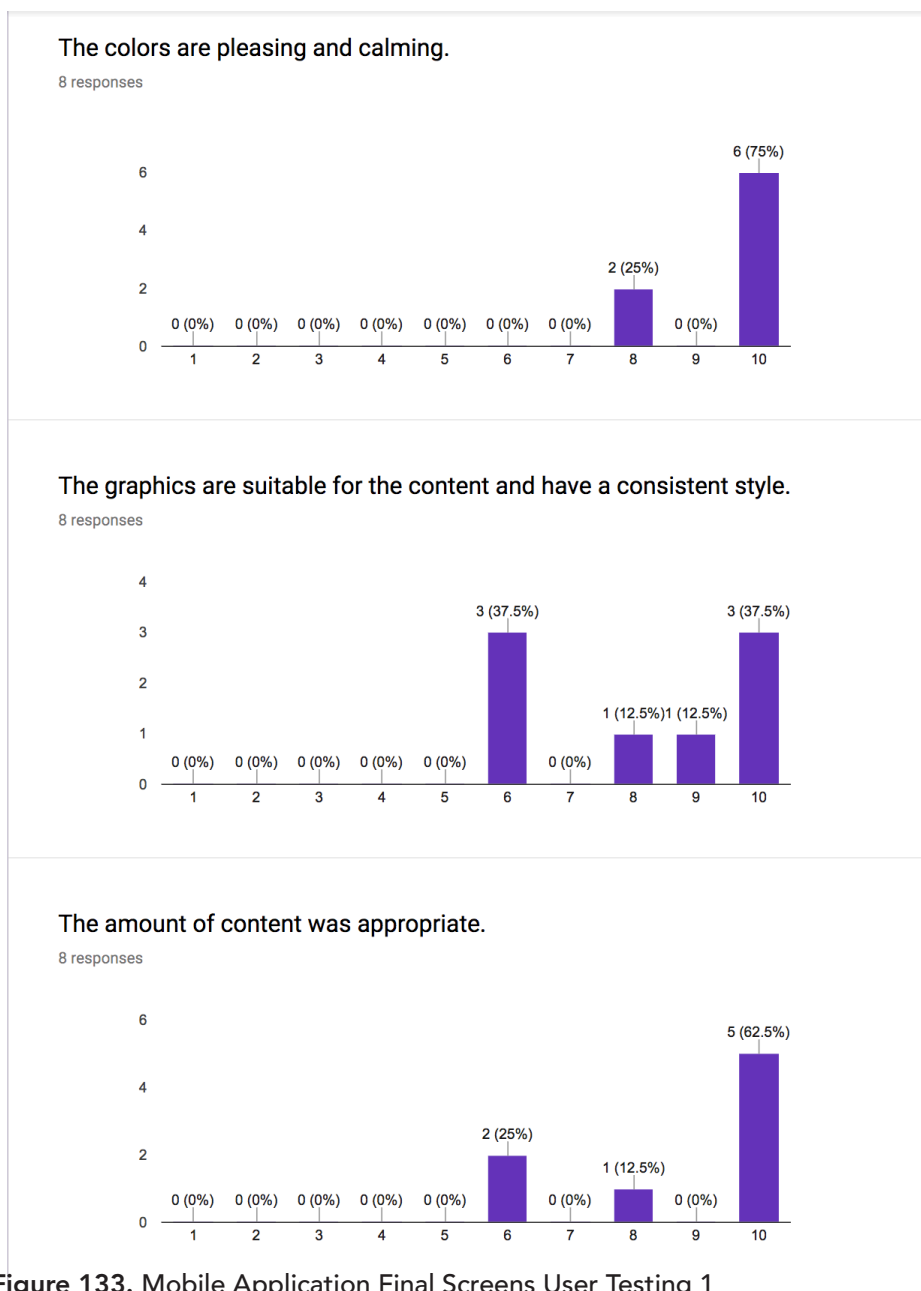


Figure 133. Mobile Application Final Screens User Testing 1

## Mobile Application Final Screens User Testing 1.2

What do you enjoy about this app?

8 responses

Everything
Everything
Calms me down.
The ease of navigation and its approachable utility
The colors and overall style.
I enjoy the colors and the effects in this app.
It is relaxing.
I liked everything.

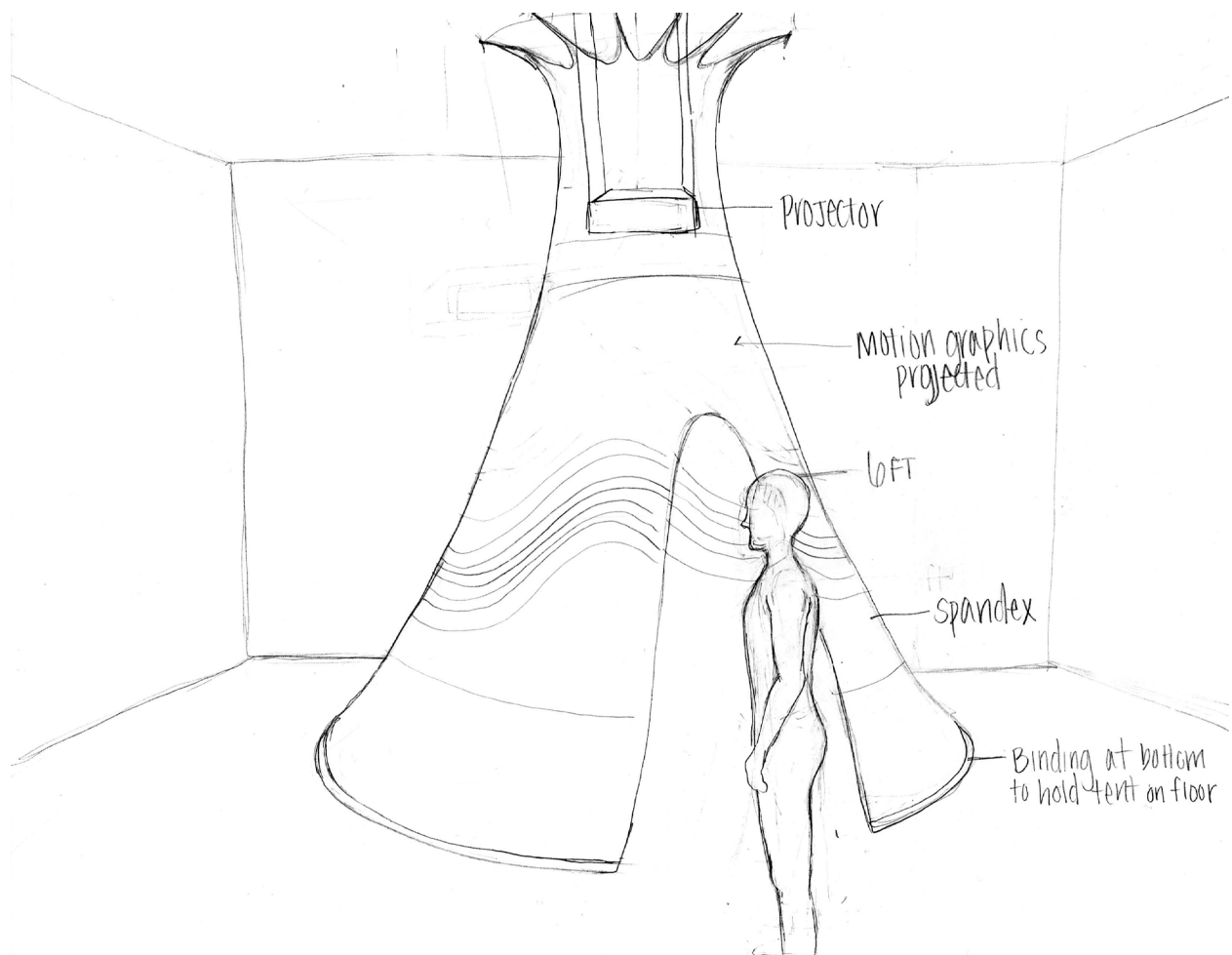
Would you be likely to use this application in a medical setting?

8 responses

Yes
Yes
Yes
Yes
Absolutely! As someone in the medical field, this app shows obvious and profound potential for use in the medical field.
Of course
I could probably use this in a medical setting.
Yes. This was very informative and great design!

Figure 134. Mobile Application Final Screens User Testing 1.2

## Biofeedback Exercise Tent Design





## **Biofeedback Exercise Tent Final Design & Installation**

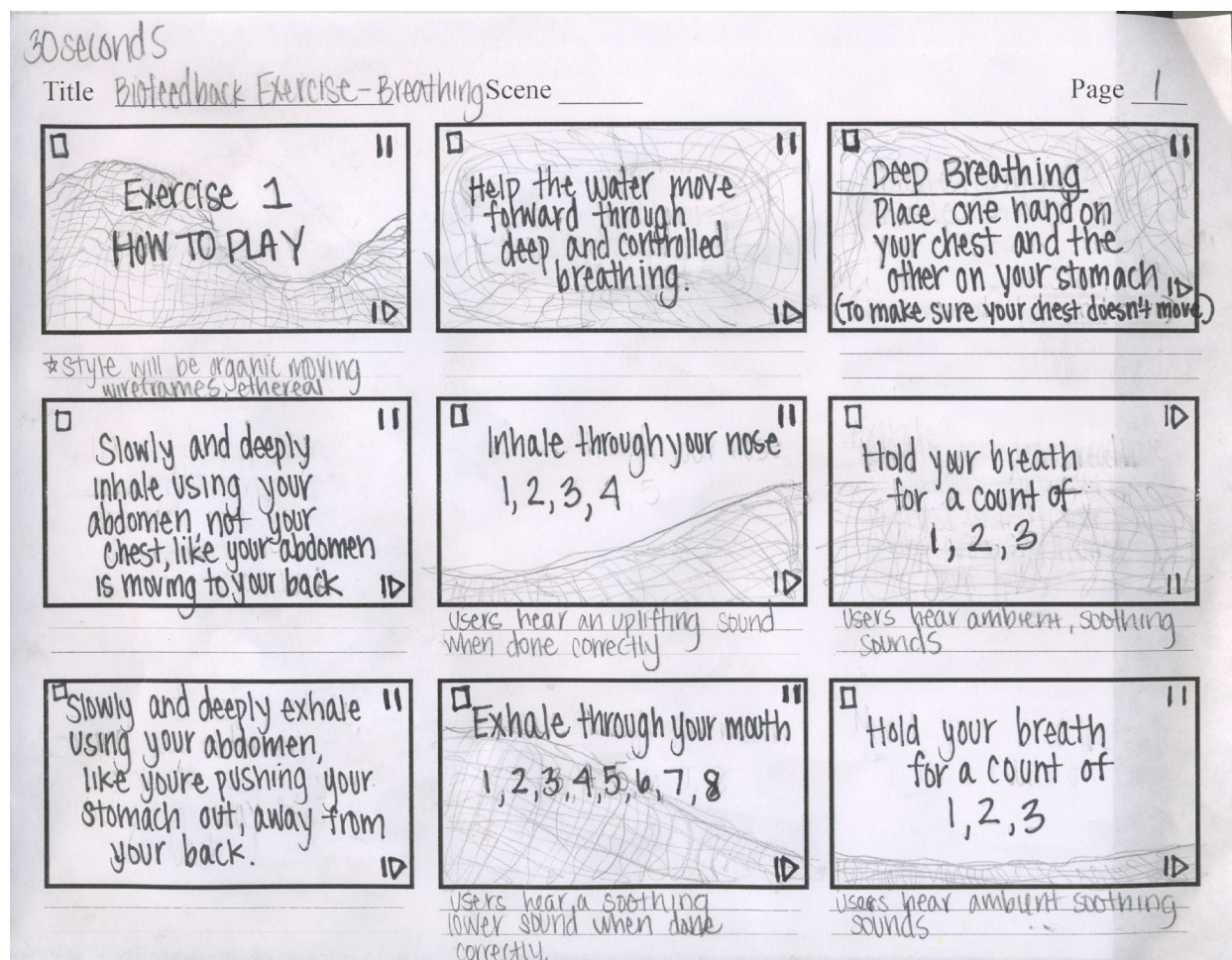


## Biofeedback Exercise Tent Final Design & Installation

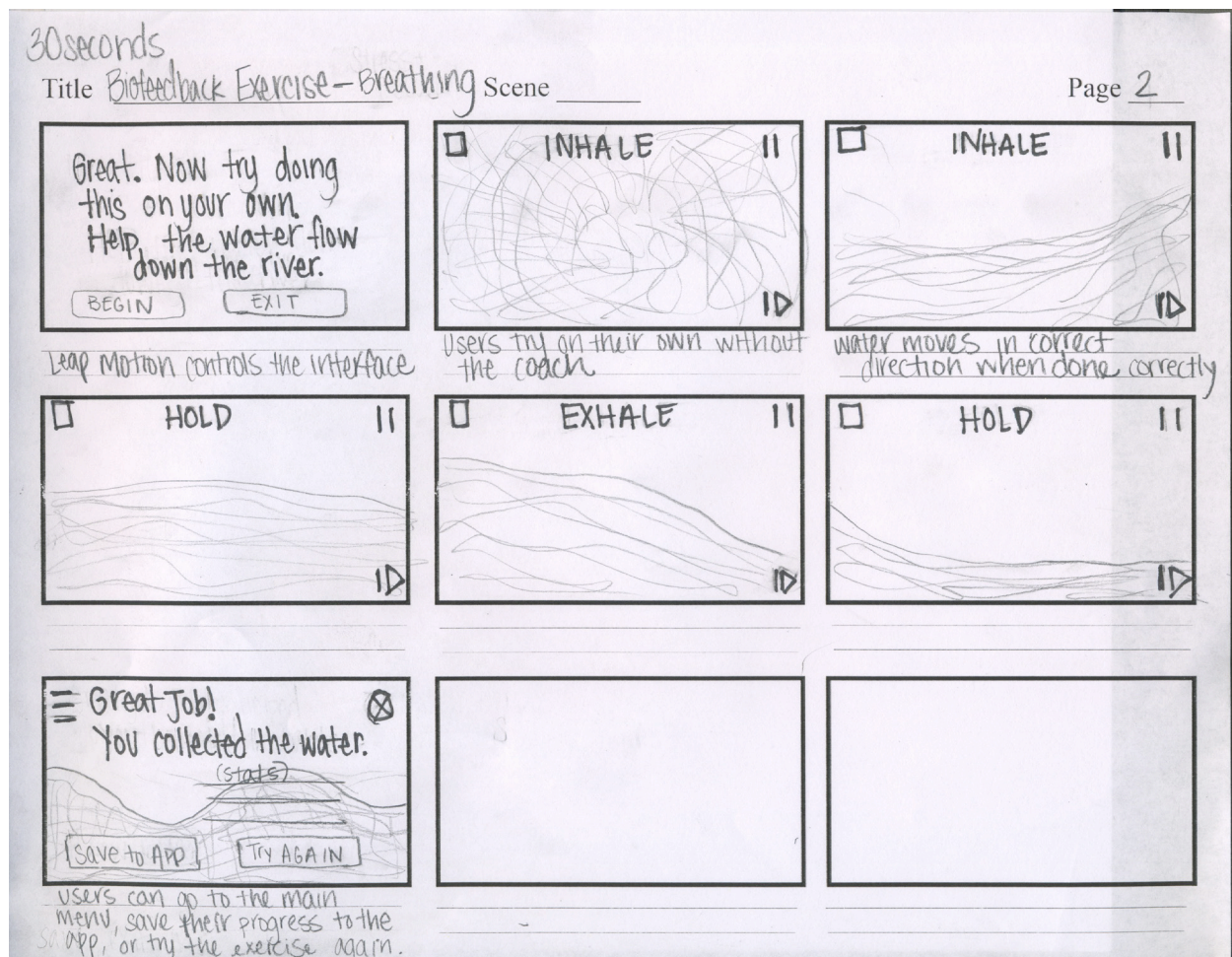




## Biofeedback Breathing Exercise Storyboard 1



## Biofeedback Breathing Exercise Storyboard 1.2



## Biofeedback Breathing Exercise Animatic

Biofeedback animatics (Figures 135-148) were created to inform the visuals, timing, and motion of the final biofeedback breathing exercise.

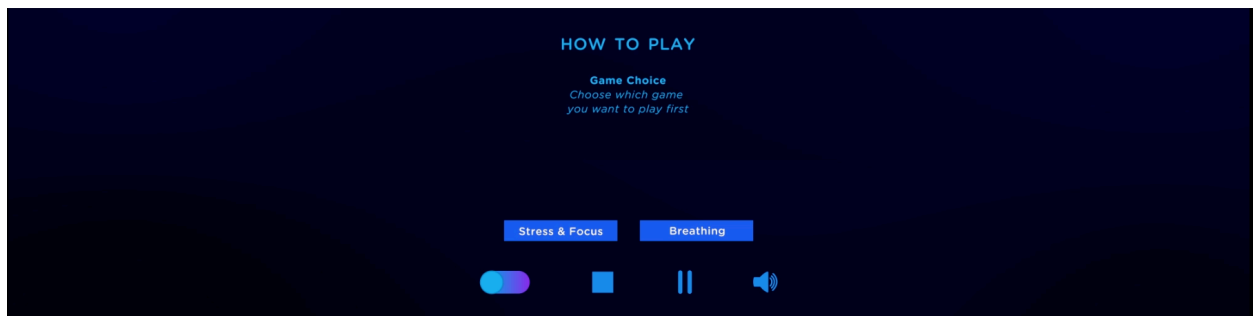


Figure 135. Biofeedback Breathing Exercise Animatic 1

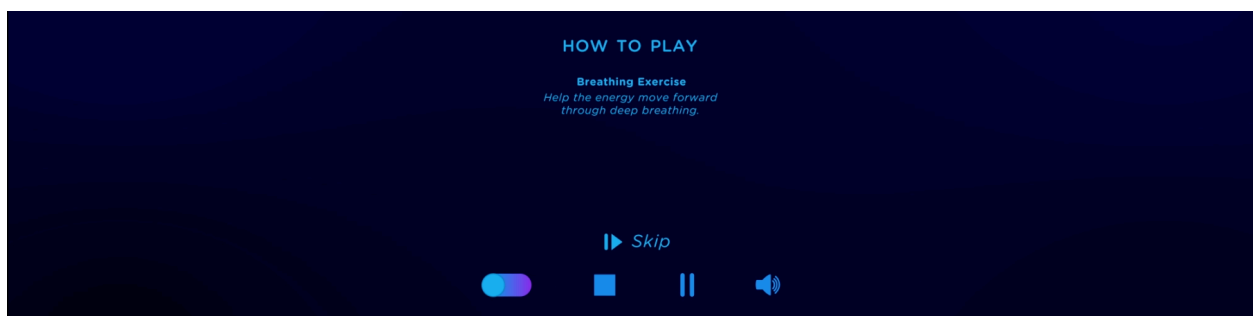


Figure 136. Biofeedback Breathing Exercise Animatic 2

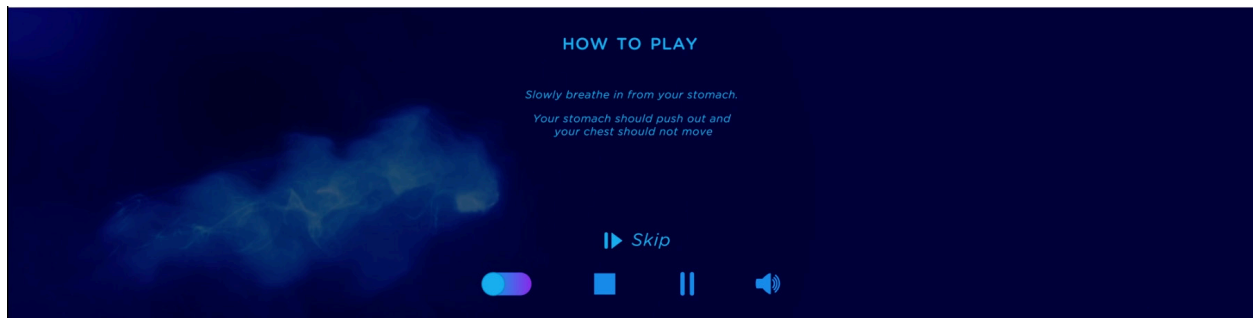


Figure 137. Biofeedback Breathing Exercise Animatic 3

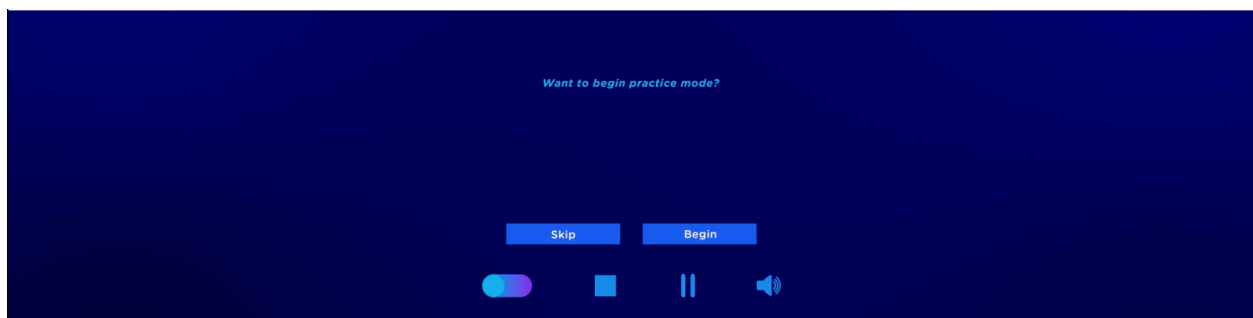


Figure 138. Biofeedback Breathing Exercise Animatic 4

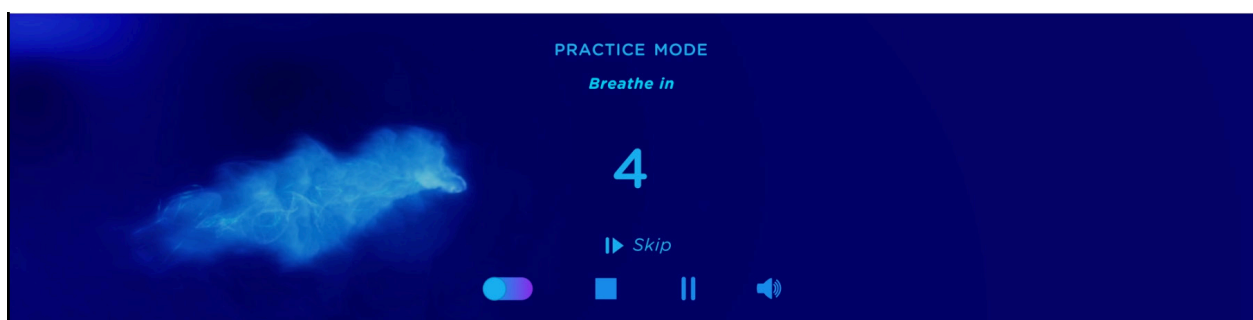


Figure 139. Biofeedback Breathing Exercise Animatic 5



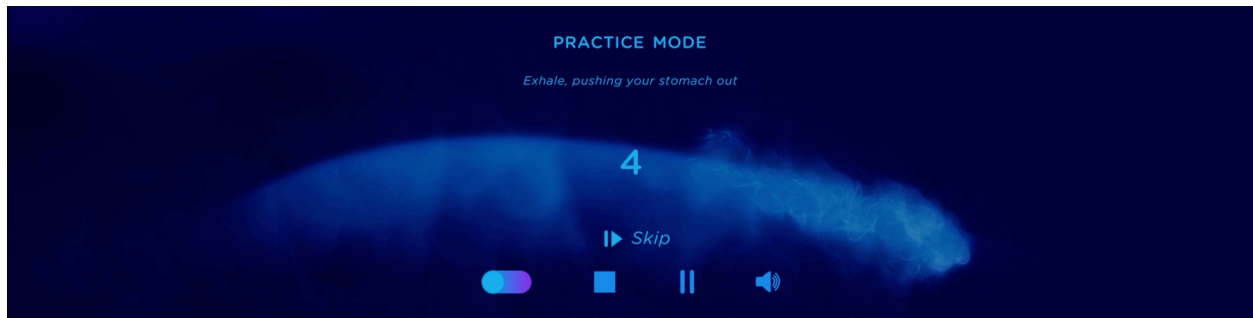


Figure 140. Biofeedback Breathing Exercise Animatic 6

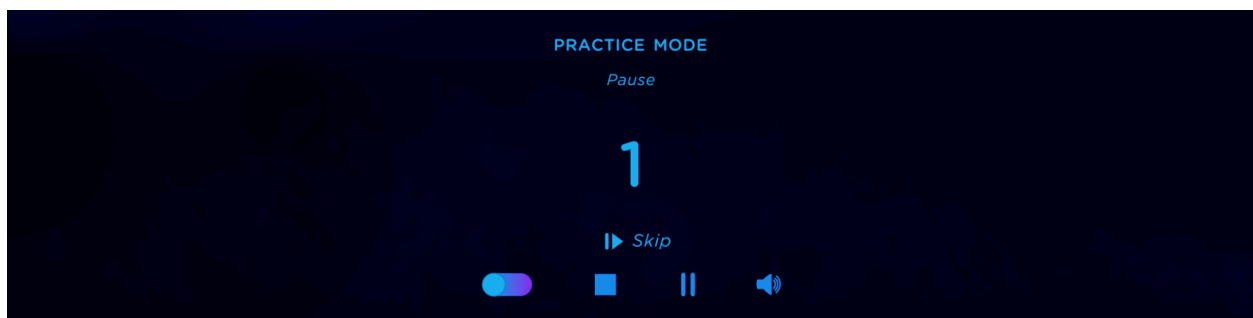


Figure 141. Biofeedback Breathing Exercise Animatic 7

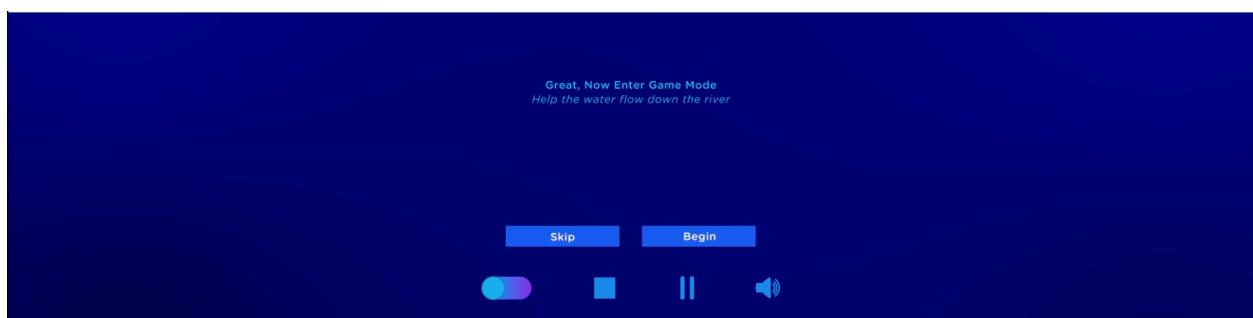


Figure 142. Biofeedback Breathing Exercise Animatic 8



Figure 143. Biofeedback Breathing Exercise Animatic 9



Figure 144. Biofeedback Breathing Exercise Animatic 10

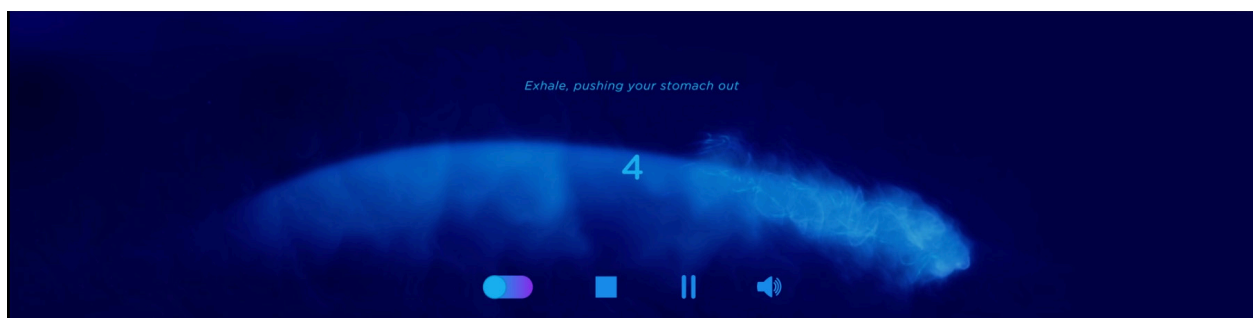


Figure 145. Biofeedback Breathing Exercise Animatic 11



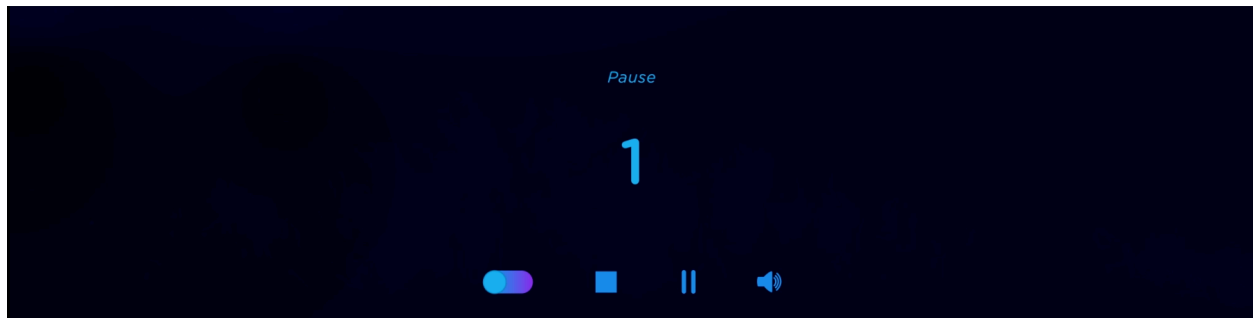


Figure 146. Biofeedback Breathing Exercise Animatic 12

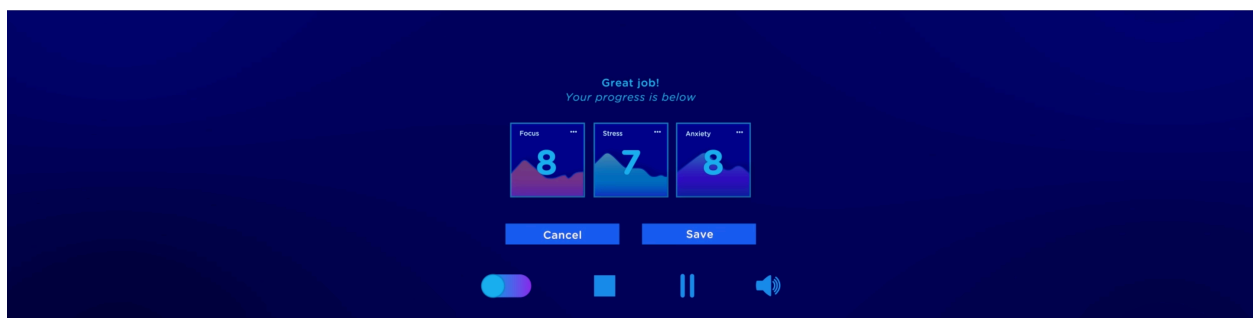


Figure 147. Biofeedback Breathing Exercise Animatic 13

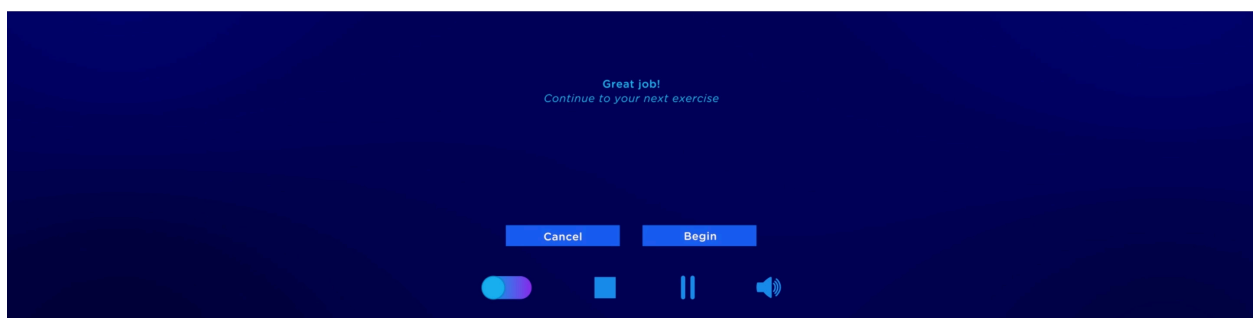


Figure 148. Biofeedback Breathing Exercise Animatic 14

## Biofeedback Breathing Exercise Final Design

Biofeedback animatics (Figures 149-169) informed the final visuals, timing, and motion of the final biofeedback breathing exercise.

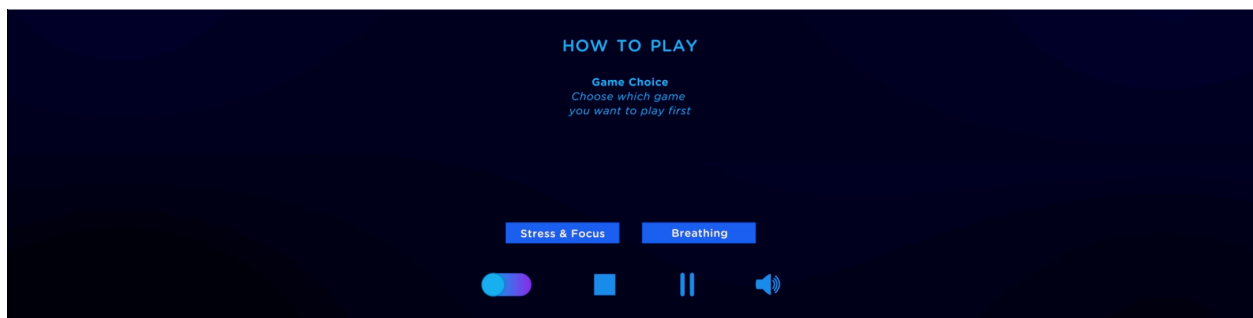


Figure 149. Biofeedback Breathing Exercise Final Screen Design 1

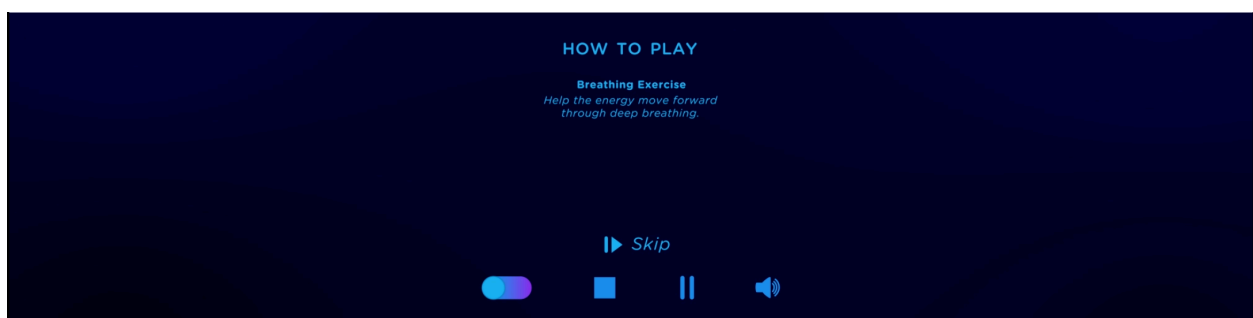


Figure 150. Biofeedback Breathing Exercise Final Screen Design 2

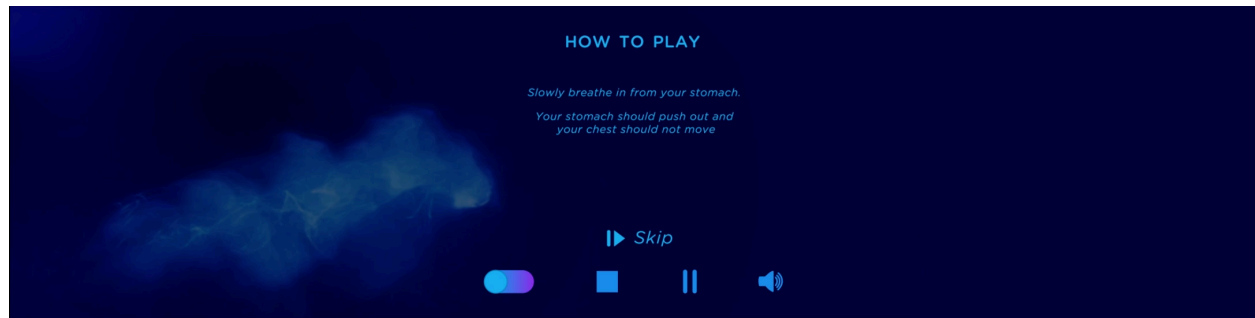


Figure 151. Biofeedback Breathing Exercise Final Screen Design 3

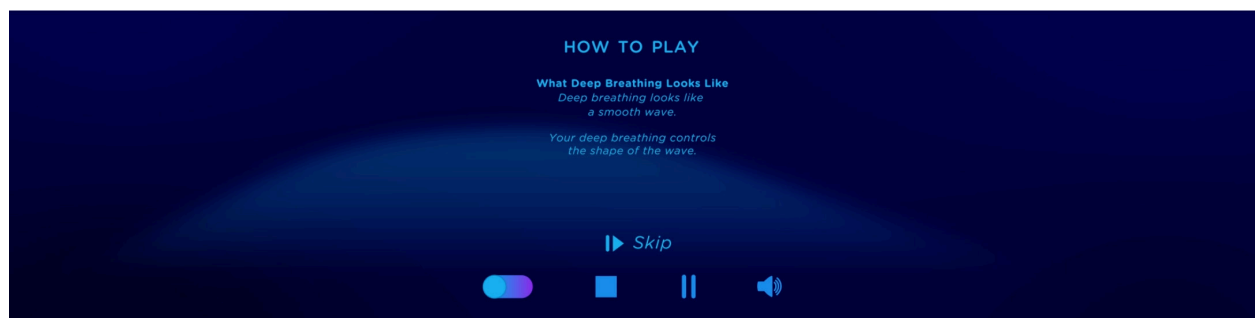


Figure 152. Biofeedback Breathing Exercise Final Screen Design 4

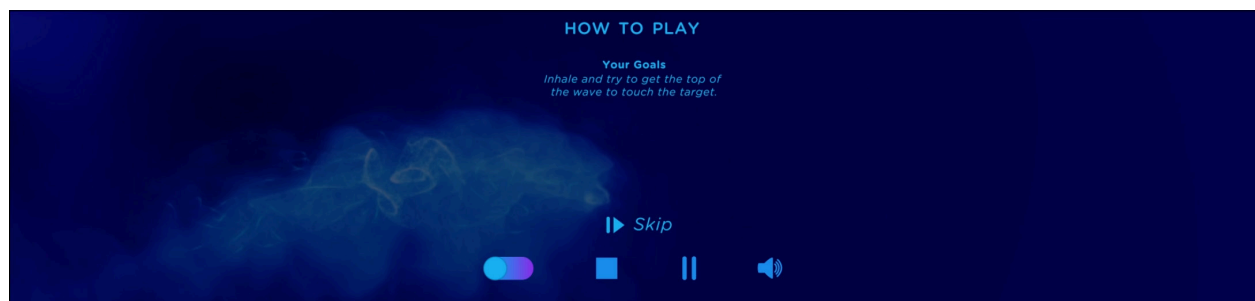


Figure 153. Biofeedback Breathing Exercise Final Screen Design 5

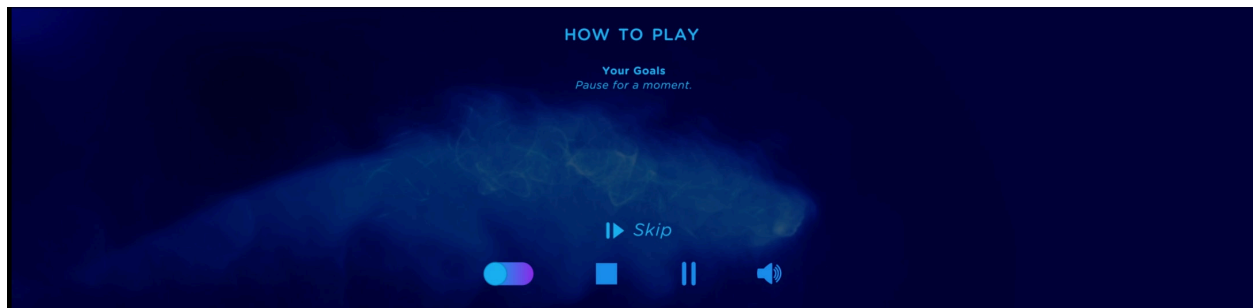


Figure 154. Biofeedback Breathing Exercise Final Screen Design 6

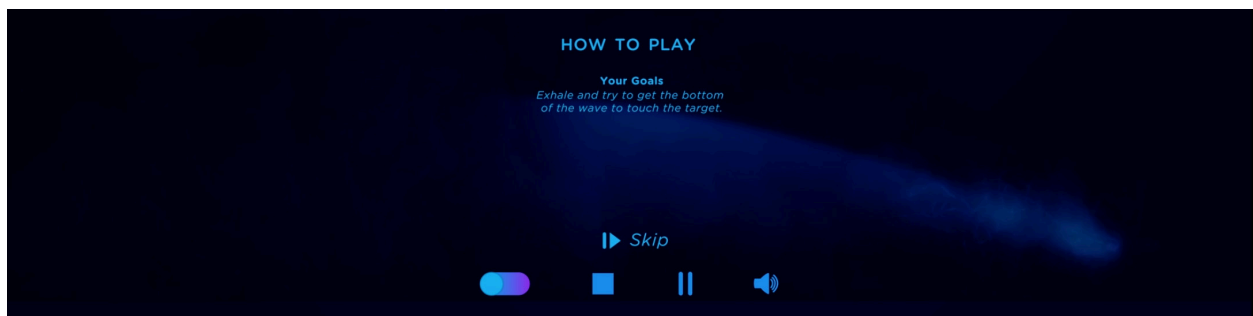


Figure 155. Biofeedback Breathing Exercise Final Screen Design 7

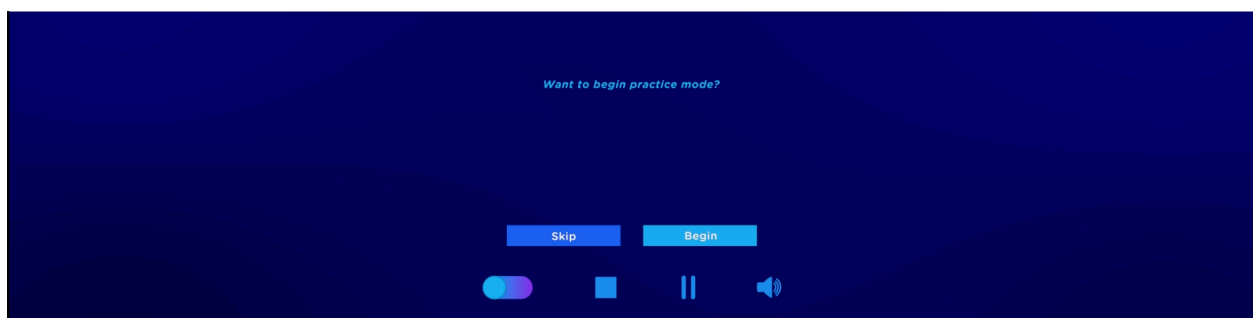


Figure 156. Biofeedback Breathing Exercise Final Screen Design 8

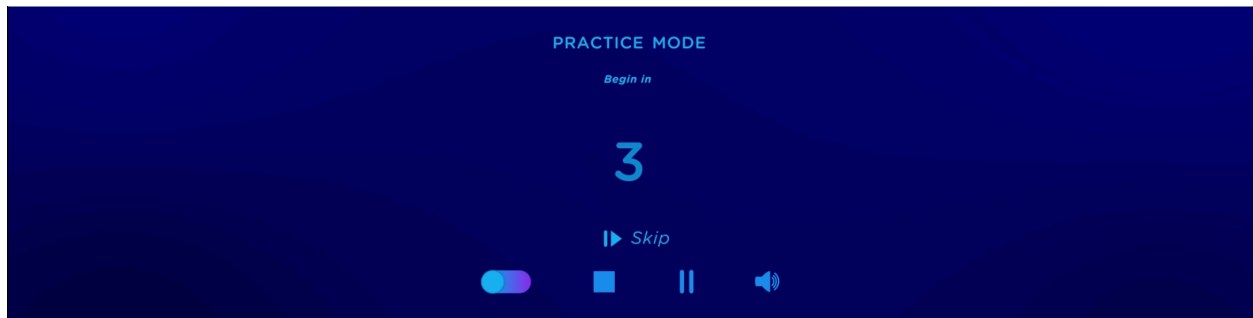


Figure 157. Biofeedback Breathing Exercise Final Screen Design 9

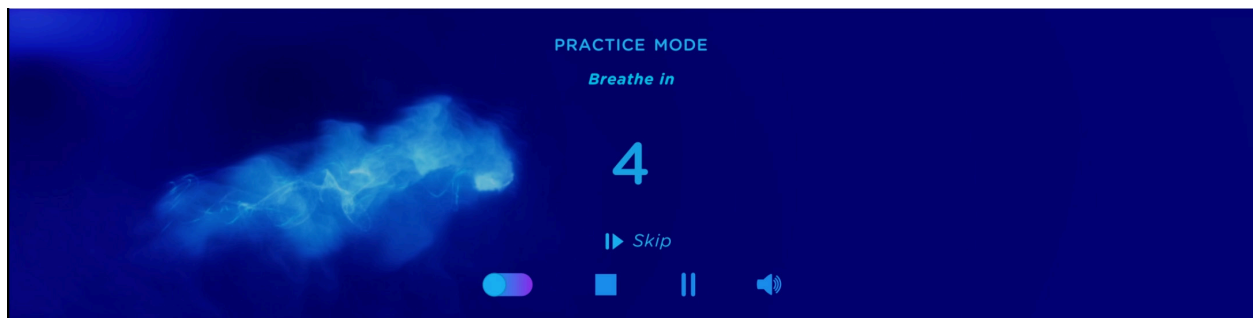


Figure 158. Biofeedback Breathing Exercise Final Screen Design 10

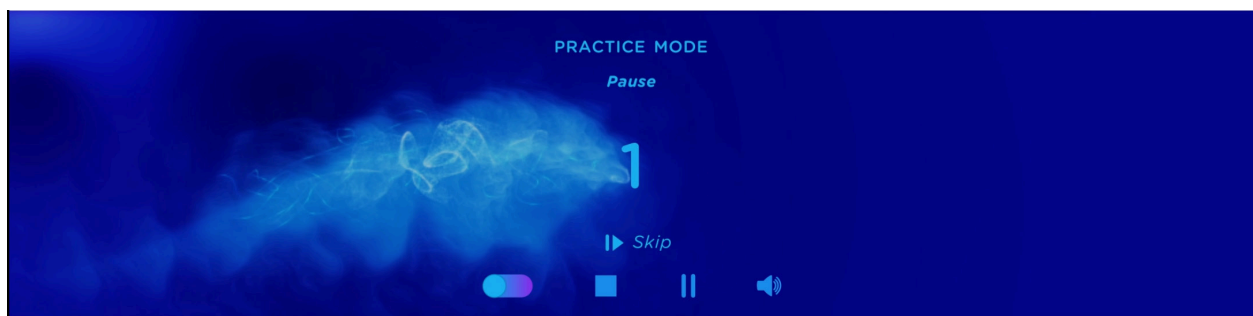


Figure 159. Biofeedback Breathing Exercise Final Screen Design 11

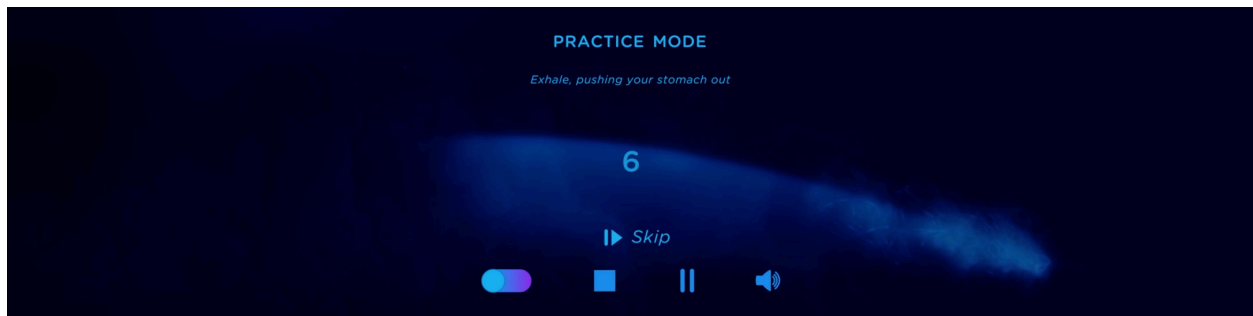


Figure 160. Biofeedback Breathing Exercise Final Screen Design 12

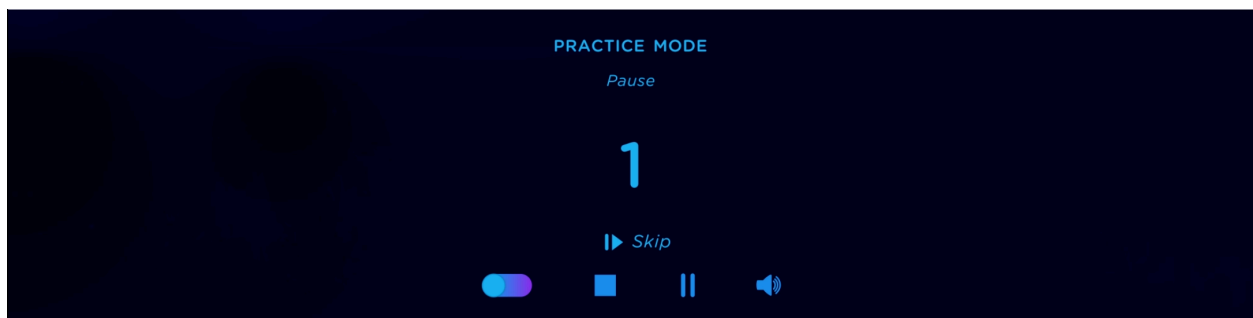


Figure 161. Biofeedback Breathing Exercise Final Screen Design 13

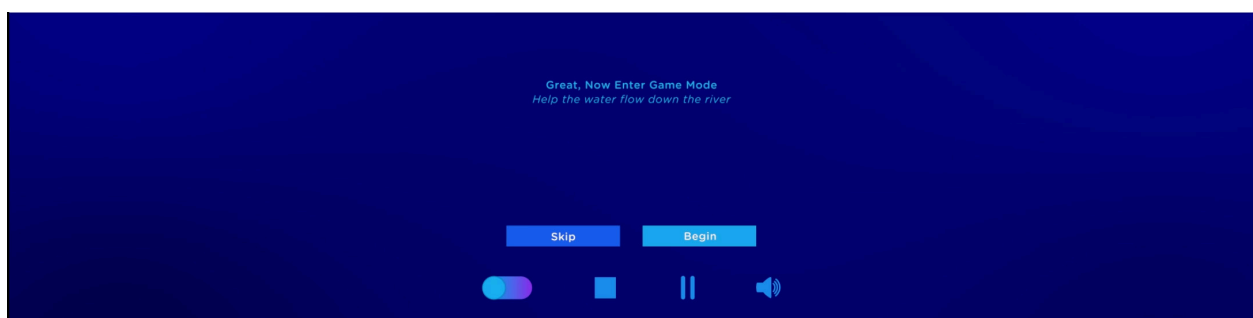


Figure 162. Biofeedback Breathing Exercise Final Screen Design 14

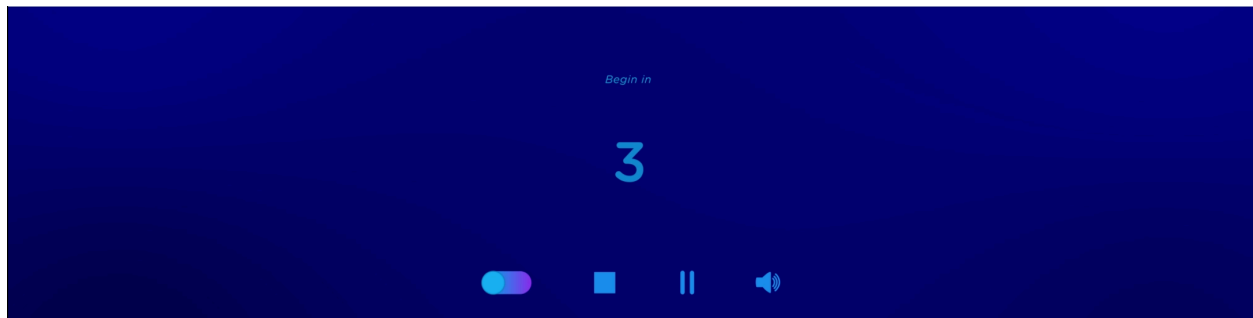


Figure 163. Biofeedback Breathing Exercise Final Screen Design 13

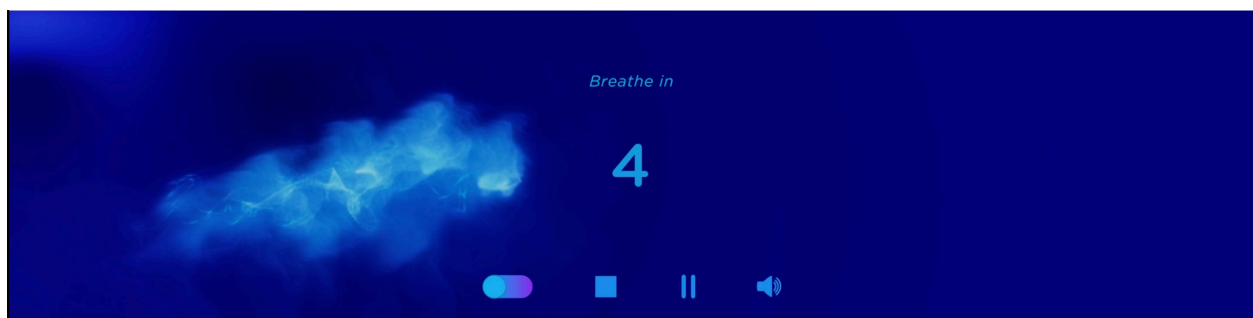


Figure 164. Biofeedback Breathing Exercise Final Screen Design 14

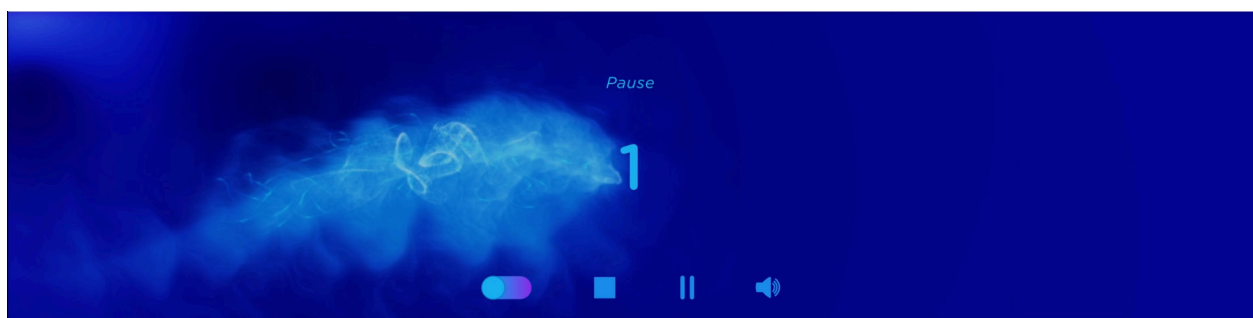


Figure 165. Biofeedback Breathing Exercise Final Screen Design 15



Figure 166. Biofeedback Breathing Exercise Final Screen Design 16

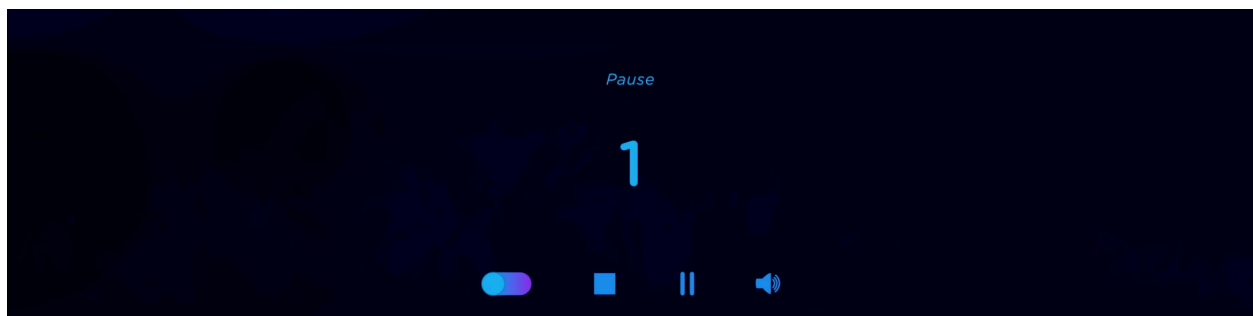


Figure 167. Biofeedback Breathing Exercise Final Screen Design 17

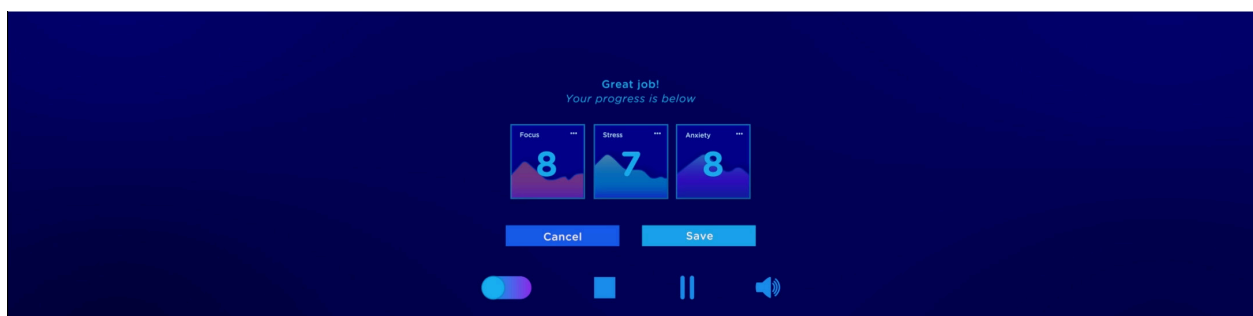


Figure 168. Biofeedback Breathing Exercise Final Screen Design 18



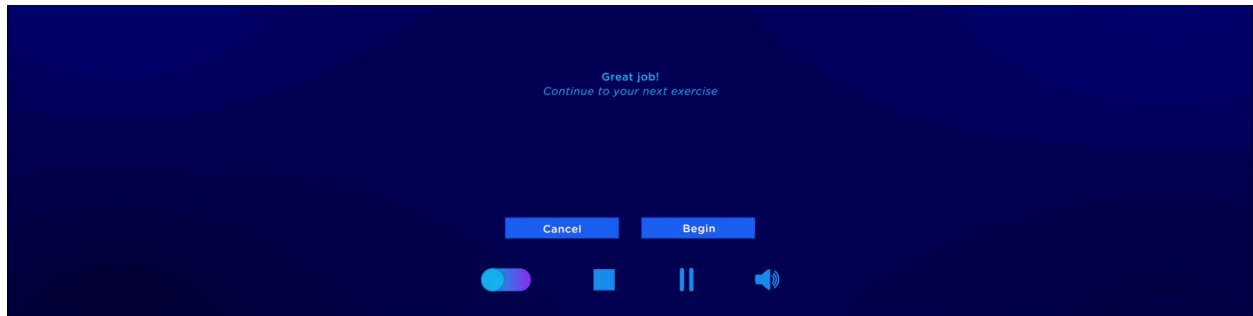


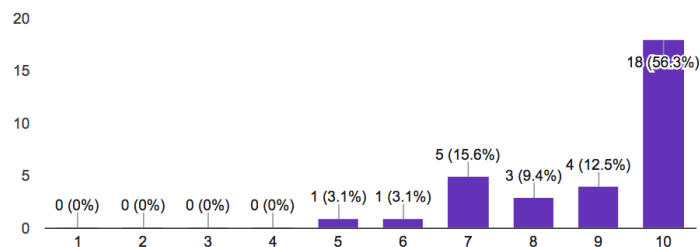
Figure 169. Biofeedback Breathing Exercise Final Screen Design 13

## Biofeedback Environment User Testing 1

User testing was done on the biofeedback environment at Imagine RIT. User feedback (Figures 170 -176) found an overwhelming positive response to the SynApps biofeedback environment. Results include testing done with volunteer autistic children and adults.

The biofeedback environment is calming and relaxing.

32 responses



The system could be effective for stress management.

32 responses

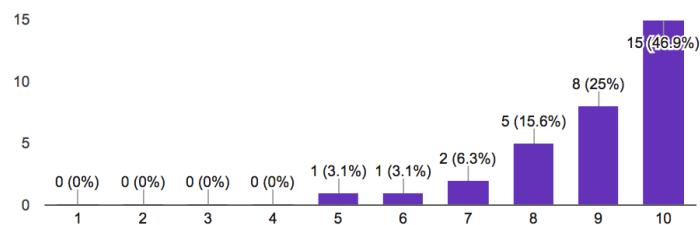
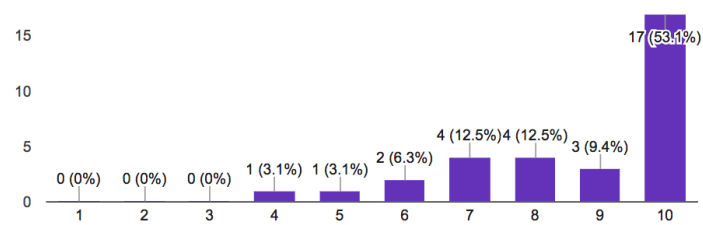


Figure 170. Biofeedback Environment User Testing 1

## Biofeedback Environment User Testing 1.2

The game was easy to follow.

32 responses



The format was easy to learn.

30 responses

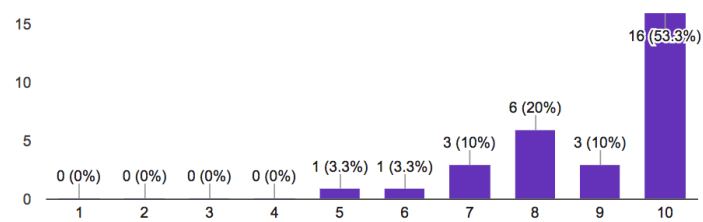
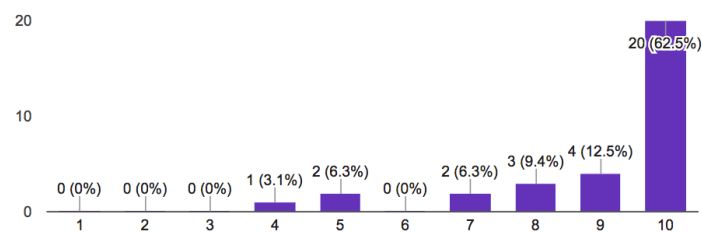


Figure 171. Biofeedback Environment User Testing 1.2

## Biofeedback Environment User Testing 1.3

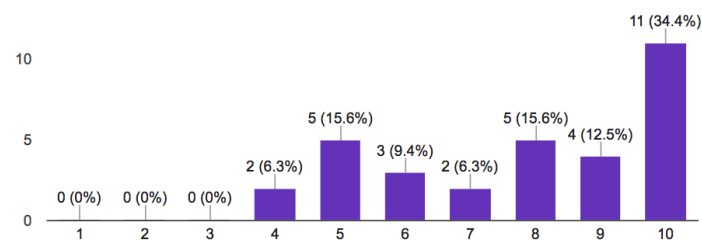
I approve of the overall visual style.

32 responses



I understand how to navigate the system.

32 responses



The type was legible.

32 responses

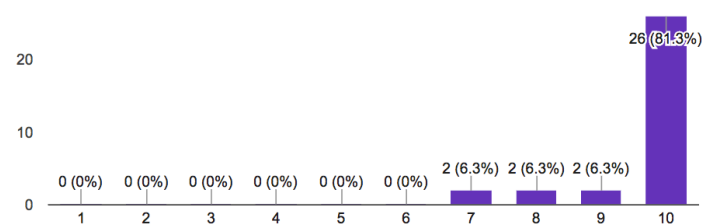


Figure 172. Biofeedback Environment User Testing 1.3

## Biofeedback Environment User Testing 1.4

J
Would you be motivated to use this system again for stress & anxiety management?
Happy
Yes, absolutely.
Definitely! It's mobile, so it can probably be set up anywhere. It could be used for reducing stress, calming anxiety and I wish I had one at my home!
Absolutely.
Yes
Yes
Yes
Sure
Yes
Yes!
Yes, and "escape" is much more appealing than just a screen.
Yes
Yes
Yes.
Yes.
Yes
It would be interesting to see more exercises.
Yes
Yes
Yes! Everyday.
I don't have much need for it and it feels like something you would only need to do a few times. Kinda like its training more than inexperience.
Yes
Yes
Yes
Yes
Yes.
Yes
Absolutely!
Yes

Figure 173. Biofeedback Environment User Testing 1.4

## Biofeedback Environment User Testing 1.5

What do you enjoy about this experience?
Calm, happy
The idea and ease of use of the application.
I like how calming, comforting, and safe and peaceful the environment is!
The isolation chamber and visual experience was wonderfully calming, accomplishing a great deal in a short period of time.
The overall experience
Very calming
It's calming and it has nice music.
Quiet, focused space.
The 360 degree submersion was more calming.
The calming nature
Re-teaching rather than exercising is cool. Being immersed is great.
The surrounding environment makes it feel less stressful
The app is well designed and the environment is really cool.
Background was very soothing design was sharp and easy to follow.
I love how immersive and calm it was.
Potential for relaxation and breathing blue color.
It seems easy to use and relaxing.
Calming
That is relaxing and calming.
The color and music calmed me a lot. Very soothing and calming.
The immersion was nice.
Calm and relaxing
Everything
It is very relaxing
I feel really relaxed and I feel like I'm about to fall asleep (especially with the blue colors).
Everything
It really calming
The ease of navigation and its approachable experience.
Calms me down

Figure 174. Biofeedback Environment User Testing 1.3

	K
Comments	
Calms me down	
It is a brilliant idea with amazing real world applications. It would offer a greater access for those who really need the help of these services. Fantastic job! I know I will hear about this in the future!	
It's mobile, so it can probably be set up anywhere. It could be used for reducing stress, calming anxiety and I wish I had one at my home!	
The care and attention to detail that was applied to this project was evident. A tremendous idea that can be easily and rapidly implemented with prompt results.	
Good job!	
and "escape" is much more appealing than just a screen.	
10/10!	
ound was vry soothing design was sharp and easy to follow.	
Very cool concept.	
uld be interesting to see more exercises.	
The system was very relaxing!	
Great idea, hope it works! Keep at it, this has a lot of potential!	
Ceiling to floor environment is really nice!	
I liked the smoky wave.	
This is very informative and great design!	
I enjoy the colors and the effects in this app, it helps calm me down. I would use this.	
Great job! I would definitely use this and I am in the medical field.	

**Figure 175. Biofeedback Environment User Testing 1.3**

## Biofeedback Environment User Testing 1.7

J
Would you be motivated to use this system again for stress & anxiety management?
Happy
Yes, absolutely.
Definitely! It's mobile, so it can probably be set up anywhere. It could be used for reducing stress, calming anxiety and I wish I had one at my home!
Absolutely.
Yes
Yes
Yes
Sure
Yes
Yes!
Yes, and "escape" is much more appealing than just a screen.
Yes
Yes
background was vry soothing design was sharp and easy to follow.
Yes.
Yes.
Yes
It would be interesting to see more exercises.
Yes
Yes
Yes! Everyday.
I don't have much need for it and it feels like something you would only need to do a few times. Kinda like its training more than inexperience.
Yes
Yes
Yes
Yes
Yes.
Yes
Absolutely!
Yes

Figure 176. Biofeedback Environment User Testing 1.3



## Evaluation & Conclusion

SynApps could potentially serve as a system used in a medical professional's office. Comprehensive research highlights a need for more comprehensive, cohesive, and engaging interactive biofeedback solutions that help alleviate the symptoms of ASD in young adults. While there are current biofeedback games that exist, they are limited to a computer screen, have disjointed visual styles, and lack a holistic approach toward the user's health.

Designing the visual style was based on research found on visual preferences for people with ASD. Research on how color affects young adults with ASD proved that aesthetics was another important piece to the development and creation of the mobile application and biofeedback exercise. Color and visual style testing (Figures 81 & 85) confirmed research that cooler colors cause a calming response in users. Questions included: what emotions do you associate with cool colors versus warm colors, and which visual style was more appealing and caused a calming reaction for the user. These results informed the creation and development of final visual designs. Additionally, the visual aesthetics of SynApps reinforce the goals and objectives of the mobile application and biofeedback environment; to create a calming experience for users. Additionally, these visual aesthetics help to inform and direct users throughout both interfaces. The interface's visual feedback helped users to: minimize errors and understand where information was stemming from.

Evaluations done through in-person surveys (Figures 133-134 & 170-176) prove that people are interested in utilizing a biofeedback mobile application and corresponding exercise environment in a medical setting. Responses to SynApps were overwhelmingly positive. Many parents of autistic children asked where they could buy the mobile application. The user testing and feedback prove that SynApps' mobile application and biofeedback exercise are successful. Usability testing proves that SynApps is successful in these areas: ease of use, legibility,

navigation, visual style, easy to learn, creating a calming experience, stress management, .

In conclusion, this thesis has highlighted the importance of user testing and feedback. User testing must be done in an unbiased, thoughtful, and properly recorded manner. Additionally, the analysis of user testing must be done to properly make responsible design choices. In order to create an effective user experience, designers must listen to user wants, needs, expectations, and feedback. SynApps is an important tool for young adults with ASD since there is nothing else like it currently used by medical professionals. Additionally, SynApps improves current health initiatives taken to help alleviate the symptoms of ASD in young adults.

As defined in the next section, this research could further extend to several different user case scenarios. SynApps could be developed into a product that is utilized by people with ASD of all ages in: medical facilities, schools and hospitals. SynApps could also be utilized by medical professionals treating patients with depression and anxiety.

## **Use Extensions**

Additional use target audiences and uses could extend into the following relationships:

### **Medical Facility/All ages and levels of Autism**

A medical facility could use this biofeedback system and application for people with autism of all levels and ages.

### **School/Students**

A school could implement this technology system in a room as a refocusing tool for students who could benefit from it.

### **Hospital/Patient**

Hospitals could implement this system and application in ERs for families who bring their children with autism in to the ER. This system could be utilized to calm and re-focus incoming patients who are experiencing high levels of anxiety and stress.

### **Medical Professionals/Anxiety & Depression Patients**

This biofeedback system and application could be utilized by medical professionals treating a variety of conditions including, but not limited to: anxiety and depression.

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## **Appendixes**

Appendix A Thesis Proposal

# **Children's ASDs Management Through An Interactive Mobile Application and Biofeedback Exercise**

Elizabeth Richardson

Thesis Proposal for the Master of Fine Arts Degree

Rochester Institute of Technology  
College of Imaging Arts and Sciences  
School of Design  
MFA Visual Communication Design

# Thesis Proposal Approvals

Rochester Institute of Technology  
College of Imaging Arts and Sciences  
School of Design  
MFA Visual Communication Design

## Thesis Committee Approval

### Chief Thesis Adviser

Dan DeLuna, Associate Professor  
College of Imaging Arts and Sciences, Visual Communication Design

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Signature of Chief Thesis Adviser

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Date

### Associate Thesis Adviser

Chris Jackson, Professor  
College of Imaging Arts and Sciences, Visual Communication Design

---

Signature of Associate Thesis Adviser

---

Date

### Associate Thesis Adviser

Dr. Laurence Sugarman  
Institute of Health Sciences and Technology, The Center for Applied  
Psychophysiology and Self-Regulation

---

Signature of Associate Thesis Adviser

---

Date

### MFA Thesis Candidate

Elizabeth Richardson  
Visual Communication Design, College of Imaging Arts and Sciences

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Signature of MFA Thesis Candidate

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Date

## Abstract

The purpose of this thesis is to explore how to provide better access to alternative treatment options in the form of an immersive biofeedback exercise for children with autism spectrum disorders (ASDs) and their families. This proposal also seeks to connect children with ASDs and their families to medical and behavioral professionals, and treatment facilities.

The implementation of this project will be done through motion graphics piece that depicts a wireless mobile application connected to biofeedback sensors worn by users with ASDs. Users participate in a biofeedback exercise presented in a game format, in which their real-time biofeedback is monitored, and then transmitted to the mobile application and processed through visuals back to the user in a closed loop. The mobile application analyzes and identifies biofeedback that is outside the norm through the comparison of existing normative data and then targets those areas through manipulations of the application's visuals. The game will promote deep and consistent breathing, deep focus, and controlled stress levels.

If done consistently, the biofeedback exercise may help aid children with ASDs in learning how to re-train how their body responds to stressful situations, leading to functional and behavioral improvements in everyday life. Additionally, this treatment application aims to be a preventative health option for children with ASDs as a means to hopefully diminish the lifetime costs that correlate with people with ASDs.

This is done first by analyzing why it is important to do so. Next, a review of the literary research examines the work researchers and predecessors have contributed to the topic of biofeedback treatments as a means to diminish the effects of autism. After that, ideation documentation is done considering possible outcomes that promote people with ASDs to engage with biofeedback exercises as a means of therapy. A methodology is laid out detailing the steps required for this proposal, and to learn more about this design so that it can be successfully recreated. Keeping in mind all of these aspects, a timeline is developed for the design of a motion graphics piece and a non-working mobile application.

This topic is important to the field of design and the broader community because it utilizes the power of design, motion, and interactive technology to potentially bring about improvements to the lives of children with ASDs. In addition, this proposal seeks to resolve a disconnect that currently exists between medical science, medical and behavioral professionals, educators, and children with ASDs and their families. Furthermore, this proposal enhances the field of design through its unification of design with science as a means to bring better health care access and support services for people with ASDs, an area that is under-explored and underdeveloped.

**Keywords**

Autism, ASDs, Biofeedback, Exercise, Visual, Interactive Mobile Application, App, User-Experience Design, User-Interface Design, UX, UI, Information Design, Wearable Design, Medical Technology, Health, Brain Computer Interface (BCI), Wireless

## Situation Analysis

Autism spectrum disorders (ASDs) is a term used to define complicated disorders around brain development.<sup>1</sup> ASDs is currently incurable and the U.S. Centers for Disease Control and Prevention identifies that ASDs affects around 1 in 68 American children, or more than 3.5 million Americans.<sup>1</sup> Recently, government ASDs statistics show that diagnoses have risen from ten to seventeen percent. People with ASDs experience varying degrees of difficulties with both verbal and non-verbal communication and social interaction, language, and repetitive behaviors.<sup>1</sup> As a result, people with ASDs may isolate themselves, not react or become indifferent to social interactions, and have trouble communicating. These symptoms are a result of a proprioceptive dysfunction, or an inability to receive accurate feedback about the body.

The cost in the United States for a person with ASDs, with an intellectual disability, over a lifespan is \$2.4 million on top of the average of \$250,000 to raise a child without ASDs.<sup>3</sup> Ostrow suggests that most of these costs occur in adulthood due to loss of employment, inability to maintain a job, the need for medication and special education, and in some cases residential care. Ostrow continues by adding that, many adults with ASDs cannot monetarily contribute toward the maintenance of their disorder because they either: did not graduate from school and cannot get a job, or cannot maintain a job. Early diagnosis followed by intervention can cut the lifelong costs of ASDs by two-thirds.<sup>2</sup> This early intervention can possibly begin with consistent biofeedback treatments.

Research has proven that sensory rooms help children with ASDs to calm down when feeling over stimulated. Interactive sensory technology can be found in these rooms including: lights, projections, interactive screens, music, enclosed structures, objects safe to chew on, tactile objects, and comfortable seating.<sup>3</sup>

Additionally, research has shown a positive correlation between biofeedback

1 Autism Speaks. 2016. Accessed September 28, 2016. <https://www.autismspeaks.org/>.

2 Ostrow, Nicole. Bloomberg. June 14, 2014. Accessed October 8, 2016. Autism Costs More Than \$2 Million Over Patient's Life.

3 "History of Multi-Sensory Rooms (MSRs)." Accessed October 4, 2016. [http://www.specialhaven.org/History\\_of\\_Multi-Sensory.html](http://www.specialhaven.org/History_of_Multi-Sensory.html).

exercises and diminished effects of autism. Studies by Sugarman, Garrison, and Williford suggest that therapy which combines biofeedback with hypnosis is effective in helping people manage the effects of ASDs.<sup>4</sup> However, there are limited biofeedback systems for children with ASDs. Most of these platforms are at a research phase or, involve participants going to medical or behavioral professionals offices, or long-term treatment facilities in order to implement biofeedback exercises. Once at a medical office, participants then participate in exercises on a small monitor with extremely poor and inconsistent visual implementations and design interfaces that are not as engaging and stimulating as they can be. Additionally, by having ASDs therapy systems that are visually inconsistent and not as visually engaging as they could be, creates limitations in the user's therapy.<sup>5</sup>

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4 Sugarman, Laurence I., Brian L. Garrison, and Kelsey L. Williford. 2013. "Symptoms as Solutions: Hypnosis and Biofeedback for Autonomic Regulation in Autism Spectrum Disorders." *American Journal of Clinical Hypnosis* 56 (2): 152-73. <http://search.proquest.com.ezproxy.rit.edu/docview/1562028291?accountid=108>.

5 Friedrich, Elisabeth V.C., Neil Suttie, Aparajithan Sivanathan, Theodore Lim, Sandy Louchart, and Jaime A. Pineda. "Brain-computer Interface Game Applications for Combined Neurofeedback and Biofeedback Treatment for Children on the Autism Spectrum." July 3, 2014. Accessed October 4, 2016. doi:10.3389/fneng.2014.00021.

## Problem Statement

### **Can immersive biofeedback exercise and corresponding mobile application be an effective means for people with ASDs to receive biofeedback therapy?**

This proposal aims to create improved access to experiential treatment possibilities and alternative therapy options for children with ASDs in addition to connecting children with autism spectrum disorders (ASDs) and their families to support systems through education, medical and behavioral professionals, and other organizations. This will be done through a one-minute motion graphics piece depicting a biofeedback exercise in session, and a non-working mobile application. The non-working mobile application is part of the same system that triggers the motion graphics piece, and can be used to save and review users' biofeedback exercise history. The biofeedback mobile application and exercise will target areas that research has shown impact effects of ASDs on children. These areas include: focus, stress, heart rate variability, anxiety, and breathing. Research has shown that biofeedback exercises diminish the effects of ASDs.

The motion graphics piece will simulate how users interact with the user-to-biofeedback-to-interface system. This is a closed circuit system as shown by the user being connected to the system, the system interpreting the user's biofeedback and sending real-time data through its bluetooth connection to the mobile app, the mobile app interpreting the biofeedback data and presenting it to the user through visual stimuli, and the user then responding to this visual stimuli, and the system then tracking the user's response and sending new biofeedback data back to the app. This process is repetitive, cyclical as the user participates with the biofeedback exercise.

The biofeedback exercise will be formatted in a game format, with an integrated reward system as a means to fully engage and intrigue the user. This proposed application enables users to participate in the exercise and receive real-time biofeedback, with the intent to re-train the body's response to stress and anxiety for a person with ASDs.



Although biofeedback is already implemented as a treatment option for ASDs, it is currently limited in its scope. Currently, if a person with ASDs wants biofeedback treatment, they most likely will need to go to a medical professional's office or treatment facility where they are seated in front of a computer or hand-held monitor. This is a limited treatment option in its inability to completely immerse the user in the therapeutic process. Additionally, those who do not have access to a medical professional practicing biofeedback treatment, or people with atypical schedules who cannot go to a medical professional's office for treatment, are unable to practice biofeedback as a therapy option. Furthermore, if a child with ASDs needs to go to a treatment facility to receive biofeedback treatment, this may not result in a consistent treatment plan since the child must leave the treatment facility at a certain point. Thus, this diminishes the long-term benefits of biofeedback treatments in possibly diminishing the effects of ASDs.

This proposal seeks to bridge this disconnect by providing access to an experiential treatment option for both facilities and at-home sensory rooms with the oversight of a medical professional. In the case of this proposal utilized in a treatment office, medical or behavioral professional's could implement this system for appointments. Through this system, children with ASDs will access to an immersive therapy option.

## Survey of Literature

### **ASTEP - Asperger Syndrome Training & Employment Partnership**

Accessed: October 5, 2016

<http://asperger-employment.org>

ASTEP promotes the inclusion of people with ASDs in employment by educating employers and building relationships between employers and professional support organizations. ASTEP also does this through trainings with Fortune 1000 companies that help employers understand and build support programs for employees with ASDs.

### **Autism Classification System of Functioning: Social Communication (ACSF: SC) Can Child**

Accessed: October 7, 2016

<https://canchild.ca/en/resources/254-autism-classification-system-of-functioning-social-communication-acsf-sc>

CanChild is a research center. CanChild discusses the ways in which they diagnose social skill levels for children with ASDs. This is based off of a five-level system. It is used by medical and behavioral professionals as well as teachers and parents to discuss a child's levels of ability and social skills.

### **Autism Costs More Than \$2 Million Over Patient's Life**

Nicole Ostrow

June 14, 2014

<http://www.bloomberg.com/news/articles/2014-06-09/autism-costs-more-than-2-million-over-patient-s-life>

Accessed: October 8, 2016

Ostrow explains research findings that the lifelong cost to care for a person with ASDs, with an intellectual disability, can be more than 2 million dollars. This is additional to the 250,000 dollars it costs to raise a child. Special education, lack of employment, and residential care can be leading causes for these costs in adulthood. In the US, more than 3.5 million people have ASDs. The US national cost of supporting children with ASDs is 61 to 66 billion dollars each year, versus 175 to 196 billion dollars to support adults.

**Autism Speaks**

Accessed: September 28, 2016

<https://www.autismspeaks.org/>

Autism Speaks is an educational organization that serves to raise awareness about and support for people with ASDs. Autism Speaks is also actively supportive in ASDs research in creating better solutions for ASDs management.

**A Portable Sonified Neurofeedback Therapy for Autism Spectrum Disorder Patients-An Initial Evaluation**

Adrian Attard Tevisan, Paolo Cavallari, and Frederick Attard

Accessed: September 30, 2016

Doi: 10.4172/2329-6895.1000133

This research documents therapy done through a sonified neurofeedback system for children with ASDs. The research studied neurofeedback from an EEG brain-to-music system can suppress Delta waves while promoting Beta and Alpha waves. The Brain Music System turned recorded EEG information into signals for users. The study showed that kids with ASDs were able to manage symptoms of ASDs and even improved in doing so.

**Biofeedback as an alternative treatment for Autism Spectrum Disorder with Asian Americans**

Sum Yin Ruth Wong

2015

Alliant International University

Accessed November 1, 2016

<http://search.proquest.com.ezproxy.rit.edu/docview/1733680870?accountid=108>.

Wong discusses how the medical field faces obstacles in considering and including cultural factors when developing treatments for people with ASDs. Wong suggests that current methods are not as effective for Asian Americans. This includes language differences and stigmas amongst Asian Americans around psychotherapies. Wong explores biofeedback as a treatment possibility since it already has a history of effectively helping treat symptoms of ASDs.

**Brain-Computer Interface Game Applications for Combined Neurofeedback and Biofeedback Treatment for Children on the Autism Spectrum**

Elisabeth V.C. Friedrich, Neil Suttie, Aparajithan Sivanathan, Theodore Lim, Sandy Louchart, and Jaime A. Pineda

July 3, 2014

Frontiers in Neuroengineering

Accessed: October 4, 2016

Doi: 10.3389/fneng.2014.00021

This study suggests problems in the mirror neuron system are the cause of ASDs. The study also says that biofeedback is just as important as neurofeedback. The study looks at how social interactions effect heart rate. It goes on to suggest that a combined approach of neuro and biofeedback would be the most effective method of treating symptoms of ASDs. Currently, a combined brain-computer interface that combines neuro and biofeedback does not exist as a treatment option. As a result, the study creates a game that considers neuro and biofeedback in a social interaction format.

**Breaking into the Autistic Brain**

Parizad Bilimoria

Boston Children's Hospital

Accessed September 28, 2016

<http://www.childrenshospital.org/news-and-events/research-and-innovation-features/breaking-into-the-autistic-brain>

Parizad gives an overview of what ASDs is, what happens in the person's brain and the problems that occurs in the absence of MeCP2, how a child with autism has a disconnected development, his research on mice, and the benefits of EEG technology on people with ASDs.

**Characteristics of Resonance in Heart Rate Variability Stimulated by Biofeedback**

Evgeny G. Vaschillo, Bronya Vaschillo, and Paul M. Lehrer

June 2006

Springer Science & Business Media

Accessed: November 5, 2016

Doi: 10.1007/s10484-006-9009-3

The authors of this paper have previously found that heart rate biofeedback helps in treating asthma patients. This study serves as an important research example for this thesis proposal of how biofeedback, particularly heart rate variability, can help with symptoms of ASDs

**Colors of Autism Spectrum Described by Researchers**

May18, 2016

Science Daily

[www.sciencedaily.com/releases/2016/05/160518120521.htm](http://www.sciencedaily.com/releases/2016/05/160518120521.htm)

This article discusses the creation of the ACSF:SC system, which can be used to classify and diagnose levels of autism. Levels of social interactions and communication are the backbone of this study. The system can be used by medical and behavioral professionals to diagnose levels of ASDs. It focuses on what can the person do versus what they cannot do. This is an important factor when considering how to develop engaging and inclusive systems of technology for children with ASDs.

**Computer-based interventions to improve social and emotional skills in individuals with autism spectrum disorders: A systematic review**

Sathiyaprakash Ramdoss, Wendy Machalicek, Mandy Rispoli, Austin Mulloy, Russell Lang, Mark O'Reilly

April 2012

Developmental Neurorehabilitation

Accessed: November 10, 2016

Doi: 10.3109/17518423.2011.651655

The authors discuss how their objective is to review studies using computer-based interventions (CBI) to improve the effects of ASDs on people. The authors focused on the improvement of social and emotional skills through the utilization of: visual learning tools, decreasing opportunities for interruptions, and clearly explained instructions. This study found that CBIs are effective, and just as good as face-to-face guidance. CBIs help people with ASDs advance in their emotional

and social interactions. When considering medical applications, it is important to consider the possibilities and benefits of customization to a user's specific wants and needs.

### **Creating Immersive Experiences Through Experiential Branding and Wayfinding**

Paul Orban and Tim Smith

November 19, 2014

University Business

Accessed: September 15, 2016

<https://www.universitybusiness.com/article/immersive-exp>

Orban and Smith review how institutions and higher education require environments that reflect their culture. A brand combined with effective wayfinding can provide an import way for a person to understand their spatial orientation. Orban details the importance of integrating experiential branding and wayfinding to engage people as they interact with their environment.

### **Deep Brain Neurofeedback**

Brain Works

Accessed: October 10, 2016

<http://www.brainworksneurotherapy.com/deep-brain-neurofeedback>

Brain Works discusses their implementation of neurofeedback on people. They talk about the benefits of neurofeedback for children with ASDs as well as people suffering from other cognitive disorders. Their neurofeedback includes QEEG pictures of the brain. Brain Works also utilizes LoRETA imaging, or Low Resolution Electromagnetic Tomography. Through these components combined, Brain Works helps patients train their brain activity to a more efficient state. This is done through 19 sensors and a 3D LoRETA.

### **Designing Environments for Children with ASDs**

Maria Luigia Assirelli

GA Architects

[www.autism-architects.com](http://www.autism-architects.com)

The architects worked with design research centers, schools, teachers, caregivers, and children ages 15-19 with ASDs to select preferred colors for children with autism. Research found: low arousal, single shades, and cooler tones of blue and green were selected as being most effective. Patterns should be avoided. A balance between gray and color treatments was successful. These

results are important to consider when thinking about visual style and language for a thesis project.

**Designing for Interaction Immediacy to Enhance Social Skills of Children with Autism**

Monica Tentori, Gillian R. Hayes

September 26, 2010

Association for Computer Machinery

Accessed: September 26, 2016

Doi: 10.3389/fneng.2014.00021

Tentori and Hayes consider the impact social skills and behavioral intervention have on people with ASDs. They consider the importance of immediately guiding and directing behavior through positive reinforcement. This is done through research in three public schools. Tentori and Hayes implement interaction immediacy through applications and social interactions.

**Designing Interactive Technologies for Supporting Research in Autism Spectrum Disorders**

David Feil-Seifer, Matt Black, Maja Mataric, and Shrikanth Narayanan

Accessed: October 3, 2016

<http://robotics.usc.edu/publications/media/uploads/pubs/608.pdf>

Researchers found evidence suggesting that people with ASDs are more likely to increase social interactions when conversing with a robot versus another person. Furthermore, children with ASDs were more likely to initiate social interactions when interacting with a robot. Researchers are currently designing a therapy robot that helps children ASDs with social behaviors.

**Development of a parent manual on assessment -guided biofeedback for Autism Spectrum Disorders**

Mirta Romero Frimtzis

March 29, 2009

Alliant International University

Accessed November 2, 2016

<http://search.proquest.com.ezproxy.rit.edu/docview/305162795?accountid=108>.

Frimtzis develops a parent manual to raise awareness of biofeedback therapy as a treatment option for children with ASDs. Frimtzis discusses while there are many ASDs advocacy groups established, there is not enough educational materials on biofeedback treatment for children with ASDs. Frimtzis' manual on

biofeedback was found by users to be helpful, educational, and had an overall positive response.

### **Economic Burden of Childhood Autism Spectrum Disorders**

Tara A. Lavelle, Milton C. Weinstein, Joseph P. Newhouse, Kerim Munir, Karen A. Kuhlthau, Lisa A. Prosser  
February 10, 2014  
American Academy of Pediatrics  
Doi: 10.1542/peds.2013-0763

Researchers use data to estimate the annual costs for a child with ASDs. Research found that the monetary burden of ASDs is huge not only on families but also on our society. This study further supports the need for early intervention and alternative treatment technology for children with ASDs.

### **Evaluating the Effectiveness of Biofeedback in Improving Emotional Regulation for a Student with Autism Spectrum Disorder**

Elizabeth Power  
October 20, 2015  
The Chicago School of Professional Psychology  
Accessed: November 1, 2016  
<http://search.proquest.com.ezproxy.rit.edu/docview/1778844198?accountid=108>.

Power studies and assess the impact of biofeedback on an eight-year old child with ASDs. Power utilizes heart rate variability, in correlation with the child's overall emotional regulation and found that it helped the child establish a stronger emotional foundation and regulation. Heart rate is an important piece of biofeedback to consider as an area of focus for interactive applications.

### **Evaluating the Effectiveness of Biofeedback Interactive Technologies for Children with Special Needs**

Meryl Alper, Juan Pablo Hourcade, and Shuli Gilutz  
June 2012  
Association for Computer Machinery  
Accessed: September 25, 2016  
Doi: 10.1.1.690.2712&rep=rep1&type=pdf

Alper, Hourcade, and Gilutz discuss the current design trend to develop new and exciting therapeutic technologies for disabled children. Their research



highlights three under-explored areas in interactive technologies. One of these areas is participatory design, an important area when considering social interactions among children with ASDs. The authors have a featured section in their study devoted to play and technologies that helps children with ASDs manage social behavior and interactions.

### **Introducing and Illustrating Biofeedback to Young People with Autism Spectrum Disorder**

Eric Hunt, Daniel Hicks, Anna E. Hope, Brian L. Garrison, Stephen Jacobs, Laurence I. Sugarman

The Center for Applied Psychophysiology and Self-Regulation at RIT

Accessed: October 26, 2016

<http://scholarworks.rit.edu/cgi/viewcontent.cgi?article=1035&context=eatc>

This diagram represents the background of biofeedback, what it is, what DyFSS is, how it works, and improvements to this system.

### **Investigating the Autonomic Nervous System Response to Anxiety in Children with Autism Spectrum Disorders**

Azadeh Kushki, Ellen Drumm, Michele Pla Mobarak, Nadia Tanel, Annie Dupuis, Tom Chau, and Evdokia Anagnostou

July 12, 2012

Doi:10.1371/journal.pone.0059730

This study explores how and if anxiety causes changes in indicators of ANS and ASDs. It also seeks to understand and convey a pattern in these changes. Areas measured included: skin temperature, heart rate, and electrodermal activity. This was done with two groups of children, one group with ASDs, and the other with ASDs. Both groups were monitored in a baseline and an anxiety condition. Only the ASDs group showed abnormally increased heart rate during both conditions. This study suggests that ASDs is linked to over-arousal which can result in people with ASDs experiencing abnormal levels of anxiety.

### **Jacob's Ladder Center**

<http://jacobladdercenter.com/methodology/references-and-research/>

Jacob's Ladder is a center serving Pre-K through 12th graders with any neurological disorder, learning disability, or genetic disorder. 60% of their students have been diagnosed with Autism. Jacob's Ladder utilizes neurofeedback as a form of therapy for its patients.

**Long-Term Follow-Up of Self-Hypnosis Training for Recurrent Headaches:**

What the Children Say

Daniel P Kohen

2010

International Journal of Clinical and Experimental Hypnosis

Accessed November 2, 2016

<http://search.proquest.com.ezproxy.rit.edu/docview/859366602?accountid=108>

Kohen recounts a survey conducted of 178 children who were referred to hypnosis as a treatment for ongoing headaches. The survey covered current status of headaches including: intensity and frequency, treatment, how hypnosis was used, and reviews of self-hypnosis. Overall, survey responses showed that participants positively responded to hypnosis in treating ongoing headaches years following application of hypnosis. Hypnosis is related to breathing, which is also related to heart rate, and is an important element of biofeedback for people with ASDs. Thus, hypnosis should be considered when developing new treatment technologies for children with ASDs.

**Making Room for Autism in the Workplace**

Elizabeth Preston

July 21, 2016

The Atlantic

Accessed: October 5, 2016

<http://www.theatlantic.com/health/archive/2016/07/making-room-for-autism-in-the-workplace/492050/>

Preston discusses a program that helps train young adults with ASDs through virtual job interviewers. Participants learn necessary workplace skills, train for industry certifications, and complete internships. Additionally, users can practice interviewing with an avatar. At the workplace people with ASDs may experience anxiety and have trouble communicating with coworkers. Preston discusses how many adults with ASDs want to work and how recently, companies are responding positively and want to employ people with ASDs. Some companies even seek out employees with ASDs. For the avatar interviews, a hidden human operator controls the experience. Four sessions with the avatar improved user's interview scores by 80%. This program is evidence of the effectiveness of robots in helping facilitate and guide social communication and interactions among people with ASDs.

**MOSOCO A Mobile Assistive Tool to Support Children with Autism Practicing Social Skills in Real-Life Situations**

Lizbeth Escobedo, David H, Nguyen, LouAnne Boyd, Sen H. Hirano, Alejandro Rangel, Daniel Garcia-Rosas, Monica Tentori, and Gillian R. Hayes

May 5, 2012

Association for Computer Machinery

Accessed: September 26, 2016

[http://www.gillianhayes.com/wp-content/uploads/2012/08/C29\\_chi2012\\_SocialCompass\\_cameraReady-v2.pdf](http://www.gillianhayes.com/wp-content/uploads/2012/08/C29_chi2012_SocialCompass_cameraReady-v2.pdf)

MOSOCO is an augmented reality mobile application for children with ASDs. MOSOCO uses a mobile application to help children with ASDs interact with one another and practice healthy social behaviors. MOSOCO helps guide social interactions by detecting people for the user to socialize with. Once a social interaction is initiated, MOSOCO helps guide its users through the conversation with social cues. This is an important study to consider because it combines interactive mobile and AR technology to encourage behavioral changes in children with ASDs. MOSOCO does not use biofeedback.

**Positive behavioral and electrophysiological changes following neurofeedback training in children with autism**

J.A. Pineda, D, Brang, E. Hecht, L. Edwards, S. Carey, M. Bacon, C. Futagaki, D. Suk, J. Tom, C. Birnbaum, A. Rork

November 13, 2007

Research in Autism Spectrum Disorders

Accessed: September 29, 2016

<http://dx.doi.org/10.1016/j.rasd.2007.12.003>

This study tests the idea that neurofeedback training can help brain wave dysfunctions, resulting in improved behaviors in children with ASDs. The study found that its participants improved their ATEC scores, and increased their ability to maintain focus. This study suggests that neurofeedback can be an effective treatment possibility for children with ASDs.

**Postsecondary Education and Employment Among Youth With an Autism Spectrum Disorder**

Paul T. Shattuck, Sarah Carter Narendorf, Benjamin Cooper, Paul R. Sterzing, Mary Wagner, and Julie Lounds Taylor

February 16, 2012

American Academy of Pediatrics

Accessed: October 5, 2016

Doi: 10.1542/peds.2011-2864

Norton discusses research finding that young people with ASDs are less likely to go to college or get a job in comparison to their peers with other disabilities. Norton goes on to discuss how within the last decade, ASDs diagnoses have dramatically increased. Although the rate of ASDs diagnoses has increased, little research has been done on how kids with ASDs function after high school. Shattuck found that people with ASDs who were of a low socio-economic background were at an even greater risk of not furthering their education and/or maintaining a job. Shattuck deduces that the cause of this is attributed to lack of: access of services, social connections, and employment connections for impoverished people with ASDs. Shattuck says that special education programs should include a transition plan for post-high school years for those with ASDs.

**Self-Adjusting Biofeedback with a Dynamic Feedback Signal Set (DyFSS)**

Laurence I. Sugarman, Brian L. Garrison, Anna E. Hope<sup>1</sup>, Stephen Jacobs, Alex J. Glade, Michael R. Wezalis, Kelsey L. Williford

The Center for Applied Psychophysiology and Self-Regulation at RIT,

Accessed October 27, 2016

<http://scholarworks.rit.edu/cgi/viewcontent.cgi?article=1018&context=eatc>

The authors discuss how autonomic dysregulation with anxiety presents challenges for children with ASDs and how Peripheral Autonomic Biofeedback Training (PABT) is a promising solution for managing anxiety and ASDs symptoms. Sugarman and authors discuss what DyFSS is and how it is a core feature of autonomic regulation training. PABT utilizes: skin conductance level, skin temperature, low frequency heart rate variability, and respiratory rate, feeds back these signals to the user, and the user learns how to change them through directions. The user then learns how to control them and apply these skills to their everyday life.

**Social Skill Deficits and Anxiety in High-Functioning Adolescents with Autism Spectrum Disorders**

Scott Bellini

Summer 2004

Focus on Autism and Other Developmental Disabilities

Sage Publications, Inc.

Accessed: November 6, 2016

<http://search.proquest.com.ezproxy.rit.edu/docview/205057377?accountid=108>

Bellini discusses how a abnormal number of children with ASDs experience anxiety levels that are much greater than the average person. This study shows the influence anxiety has on people with ASDs and how long-term anxiety management is important in treating the symptoms of ASDs.

**Specialisterne**

October 5, 2016

<http://usa.specialisterne.com>

Specialisterne is a 501(c)3 organization focused on services and programs for businesses in the community with an interest in gaining people with ASDs as employees. Specialisterne educates corporate partners, schools, and government agencies on how to gain and maintain employees with ASDs. Specialisterne educates people with ASDs on career development and help participants find employment.

**Special Haven**

October 4, 2016

[http://www.specialhaven.org/Home\\_Page\\_2\\_2.html](http://www.specialhaven.org/Home_Page_2_2.html)

Special Haven provides multi-sensory environments for children and adults with Special Needs fora local community. Special Haven specializes in multi-sensory rooms and the benefit these rooms provide in removing stresses of the outside world for people with special needs.

**Slowing Down Emergency Rooms to Improve Autism Care**

Shefali Luthra

May 9, 2016

Kaiser Health News

Accessed: October 4, 2016

<https://spectrumnews.org/news/slowing-down-emergency-rooms-to-improve-autism-care/>

Luthra discusses how hospitals across the country are implementing separate accommodations for people with autism in their ERs due to an influx of patients with ASDs. These rooms have sensorial toys, iPads, and dimmed lights. Luthra discusses special protocols certain hospitals take when interacting with patients who have ASDs. These protocols include alerting doctors of the patient's ASDs diagnosis so that they can adjust how they interact with their patients. One in forty-five children were diagnosed with ASDs in 2014. This is a dramatic increase when compared to ASDs diagnoses in 2000 being 1 in 150. Hospitals are an important community hub to consider as a location to provide educational materials and treatment services to people with ASDs.

**Symptoms as Solutions: Hypnosis and Biofeedback for Autonomic Regulation in Autism Spectrum Disorders**

Laurence I. Sugarman, Brian L. Garrison &amp; Kelsey L. Williford

September 5, 2013

American Journal of Clinical Hypnosis

Accessed: October 0216

Doi: 10.1080/00029157.2013.768197

**Tantrums in Children with Disability and Developmental Delays  
Child and Youth Services, Disability Services**

October 2014

Accessed: October 6, 2016

[http://www.dcsi.sa.gov.au/\\_\\_data/assets/pdf\\_file/0018/13905/tantrums-in-children-with-disability-and-developmental-delays.pdf](http://www.dcsi.sa.gov.au/__data/assets/pdf_file/0018/13905/tantrums-in-children-with-disability-and-developmental-delays.pdf)

This child development resource sheet reviews tantrums in children with disabilities and developmental delays. It explains why tantrums occur, when they can occur, how to respond, prevention and early intervention methods.

**The ECHOES Technology-Enhanced Learning Environment: Facilitating Social Communication Skills in Children with Autism**

Rajendran, G, Porayska-Pomsta K, Smith T, Lemon O, Consortium TECHOES  
May 9, 2013

ECHOES Publication

The International Meeting for Autism Research

Accessed: September 20, 2016

<http://echoes2.org/?q=node/2>

ECHOES is an interactive and collaborative learning environment tool for children 5-7 years old with ASDs. Participants work on social skills by collaborating with virtual characters and objects. Manageable goals are developed and adapted based on the needs of the participant. Customizable features are an important element when working with children with ASDs to ensure an interactive game is engaging and inclusive.

**The Disconnection**

Emily Vossen

TEDx Talks

YouTube

Accessed: October 15, 2016

Emily Vossen gives a TED talk about the benefits of neurofeedback training in children with ASDs and how people without ASDs would also benefit from it. Vossen refers to neurofeedback training as yoga for the brain. She discusses how the brain is a muscle and open to being re-trained. She opened the Henry Vossen Center for children who have cognitive disorders, and implements neurofeedback training at this center. Vossen also discusses the disconnect that occurs between doctors, patients, families, and treatment centers.

**The Use of Virtual Reality Hypnosis with Two Cases of Autism Spectrum Disorder: A Feasibility Study**

David W. Austin, Jo-Anne M. Abbott, and Colin Carbis

June 2008

John Wiley, Chichester UK

Doi: 10.1002/ch.349

Accessed: November 3, 2016

This study considers Virtual Reality (VR) technology as a means to treat symptoms of ASDs in children. The study involved two boys ages 14 and 15 with

4 sessions over 2 weeks. The study looked at whether VR would reduce anxiety levels in children with ASDs. Results suggested that VR did not have a positive effect in treating symptoms of ASDs. However the parents of the participants said that they would utilize this technology if it were an available treatment option for their son. Each set of parents noticed increased levels of focus in their son as a result of VR technology being used as a therapeutic application.

**Using Virtual Environments for Teaching Social Understanding to 6 Adolescents with Autistic Spectrum Disorders**

Peter Mitchell, Sarah Parsons, and Anne Leonard

August 2006

Journal of Autism and Developmental Disorders

Accessed November 1, 2016

Doi: 10.1007/s10803-006-0189-8

The authors discuss how six teenagers with ASDs experience a Virtual Environment (VE) cafe, a video of a real cafe, and a video of buses. Participants chose where they would sit and why they would sit there for each situation. This study showed the potential in using VR technology as a treatment option and social skills tool for young adults with ASDs.

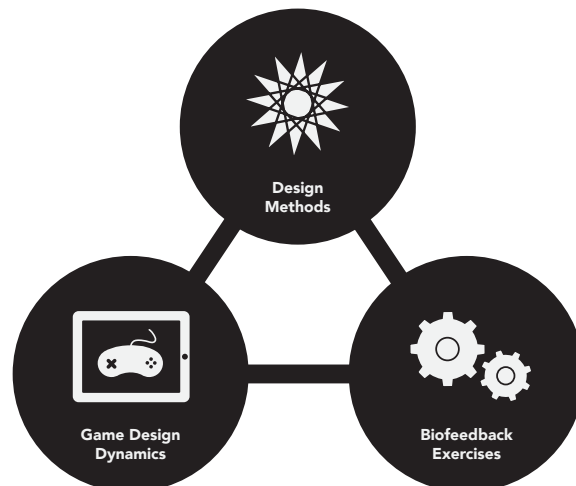


## Design Ideation

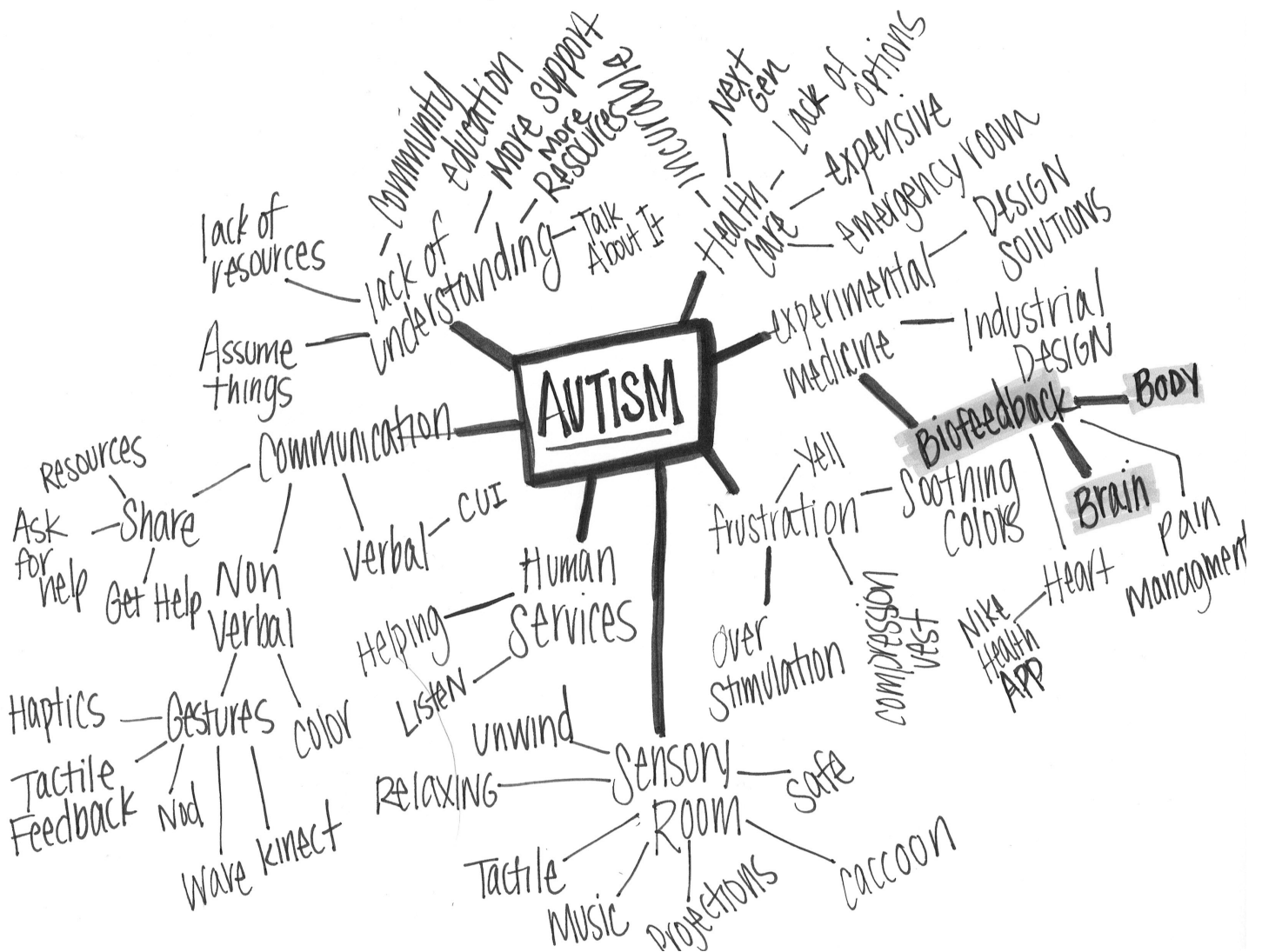
The main goal of this proposal is to integrate design methods with research findings on the benefits of biofeedback trainings for people with ASDs. This will be done through game design dynamics in the form of a one-minute motion graphics piece featuring a biofeedback exercise, and a non-working, mobile application. Both of these deliverables will educate and support people with ASDs through accessible therapeutic treatments implemented at a medical facility. Additionally, a conical-shaped structure will be built and have the one-minute motion graphics piece, depicting a biofeedback session, projected on to it. Users will be able to walk into this structure and view the motion graphics piece.

The goal of this project is not to provide a single solution for every user. Instead, the motion graphics piece depicting the structure and interactions of the game and app design, and the non-working mobile app will be unique to the person participating in the training sessions.

In addition, since symptoms of ASDs can vary person to person, users will be able to edit preference settings and personalize the app for color preference, sound levels, age level, and level of autism.



## Mind Mapping



## Color Palette Exploration

**ASDs Friendly Color  
Palette selected by  
children with ASDs**



#7691C6



#BDC0E1



#F5CFC6



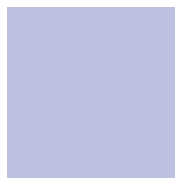
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#E5E5E5



#7691C6



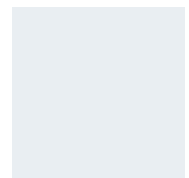
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#E5E5E5



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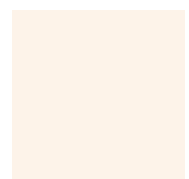
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#CDCDF3



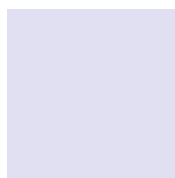
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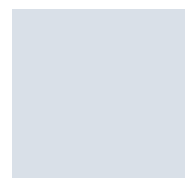
#E1E0F2



#FABFB9



#E5E7D1



#D9E0E8

## Product Name Ideation - Word Bank

Achieve	Home	Plastic
Brainwaves	Input	Processing
Care	Interaction	Social
Cerebral	Learning	Solution
Comfort	Life	Special
Connect	Links	Stimulation
Development	Malleable	Synapses
Electric	Mu waves	Therapy
Exercise	Neuro	Treatment
Experimental	Neuroplasticity	Unify
Feedback	Physiological	Yoga
Goals		

## Product Name Ideation

### Feedback of favorite names

Allo

isotonos

Me2Mu

Synapse

Synergy

## Potential Typographic Studies

Avenir Light

*Avenir Light Oblique*

Avenir Book

*Avenir Book Oblique*

*Avenir Oblique*

Avenir Roman

Avenir Medium

*Avenir Medium Oblique*

**Avenir Black**

***Avenir Black Oblique***

Avenir Heavy

***Avenir Heavy Oblique***

*Pier Sans Italic*

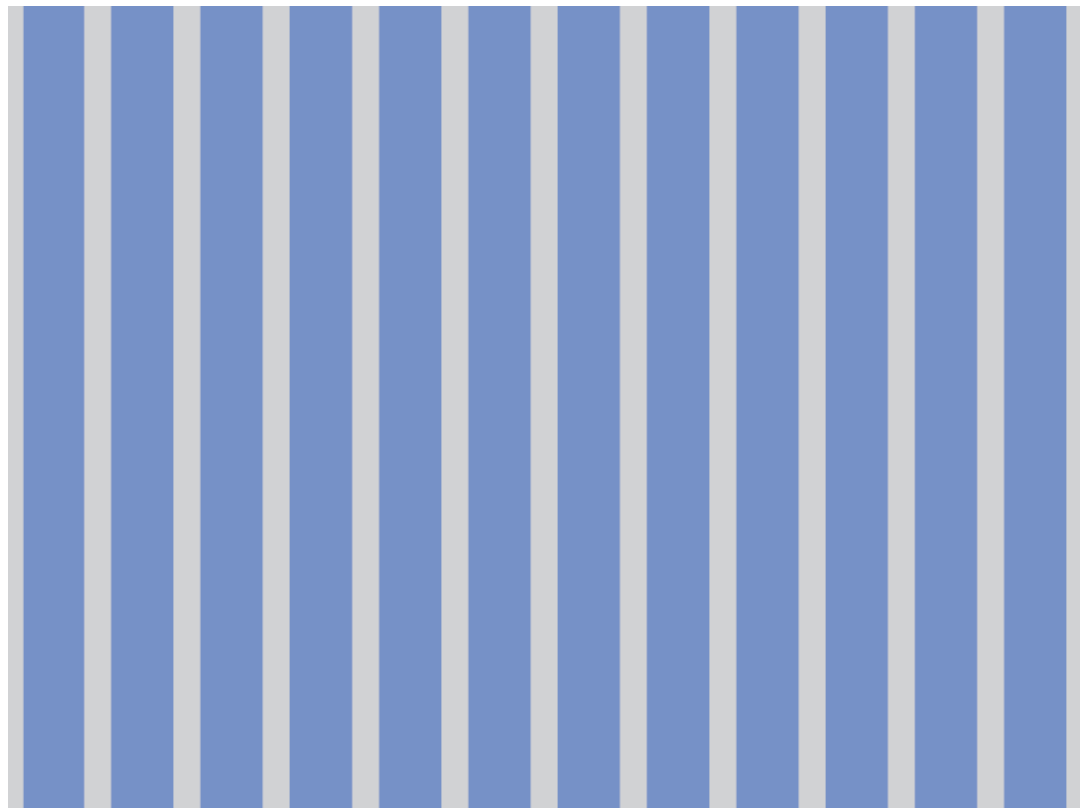
Pier Sans Regular

**Pier Sans Bold**

***Pier Sans Bold Italic***

## Potential App Grid Structure

iPad with a 12 Column Grid



# User Experience Map

## Guiding Principles

Synapse is an app designed for people with autism

People are tired of taking medications and feel frustrated because they do not have, or cannot afford to have consistent treatment care, or do not see consistent development.

People want consistent access to the best treatment care, including alternative methods to medicine.

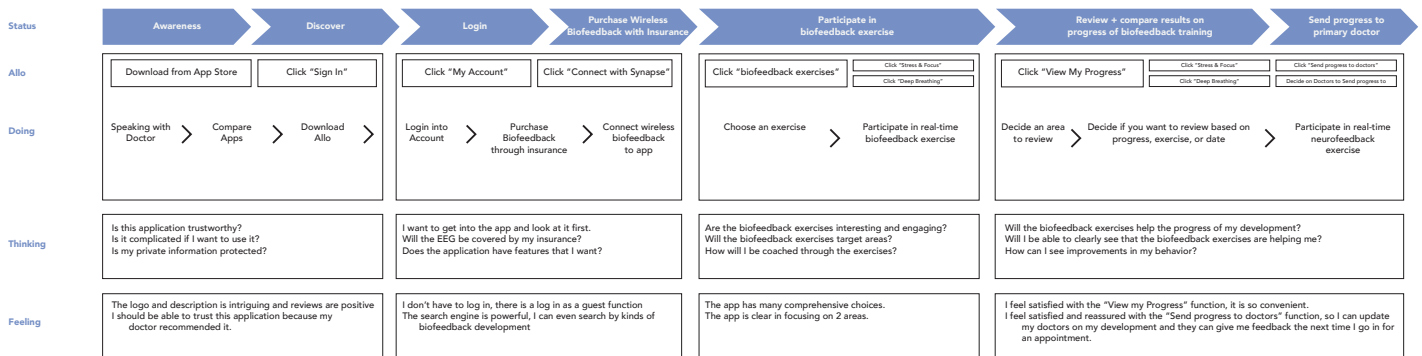
Users want to understand the current status of their development, their strengths, and areas that can benefit from improvement

Users are willing to compare behavioral areas they can develop, and participate in biofeedback exercises that are clear, engaging, and targeted for that user's ASDs level.

Users are expecting an experience that encourages and demonstrates development and they will recommend to others.

Users are willing to share their progress with their doctors, to look over and keep track of brain development

## User Journey





## User Experience Close-Up 1 of 2

### Guiding Principles

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### User Journey

Status	Awareness		Discover		Login		Purchase Wireless Biofeedback with Insurance	
Allo	Download from App Store		Click "Sign In"		Click "My Account"		Click "Connect with Synapse"	
Doing	Speaking with Doctor > Compare Apps > Download Allo >		Login into Account > Purchase Biofeedback through insurance > Connect wireless biofeedback to app				Choose	
Thinking	Is this application trustworthy? Is it complicated if I want to use it? Is my private information protected?		I want to get into the app and look at it first. Will the EEG be covered by my insurance? Does the application have features that I want?				Are the bio Will the bio How will I t	
Feeling	The logo and description is intriguing and reviews are positive I should be able to trust this application because my doctor recommended it.		I don't have to log in, there is a log in as a guest function The search engine is powerful, I can even search by kinds of biofeedback development				The app ha The app is	

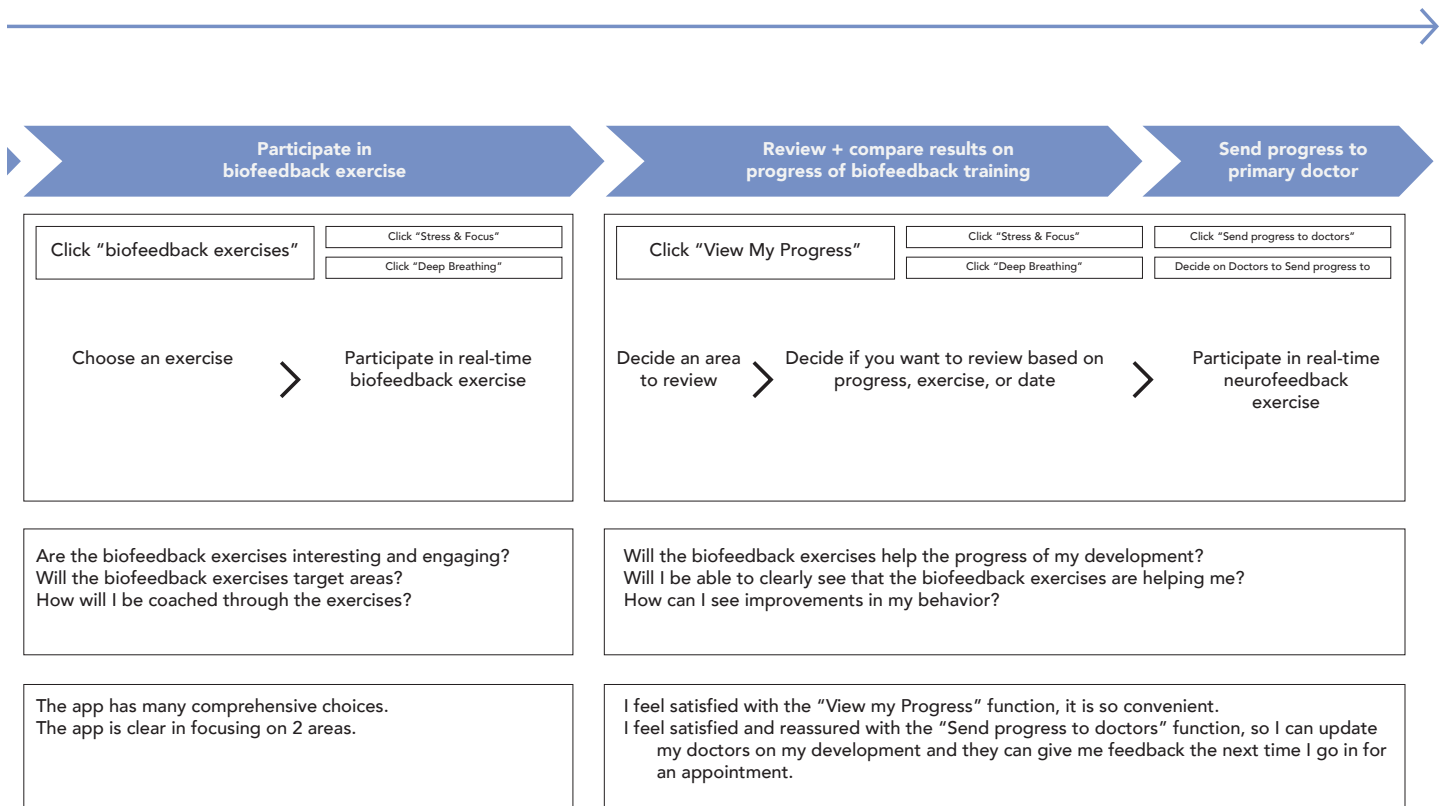
## User Experience Close-Up 2 of 2

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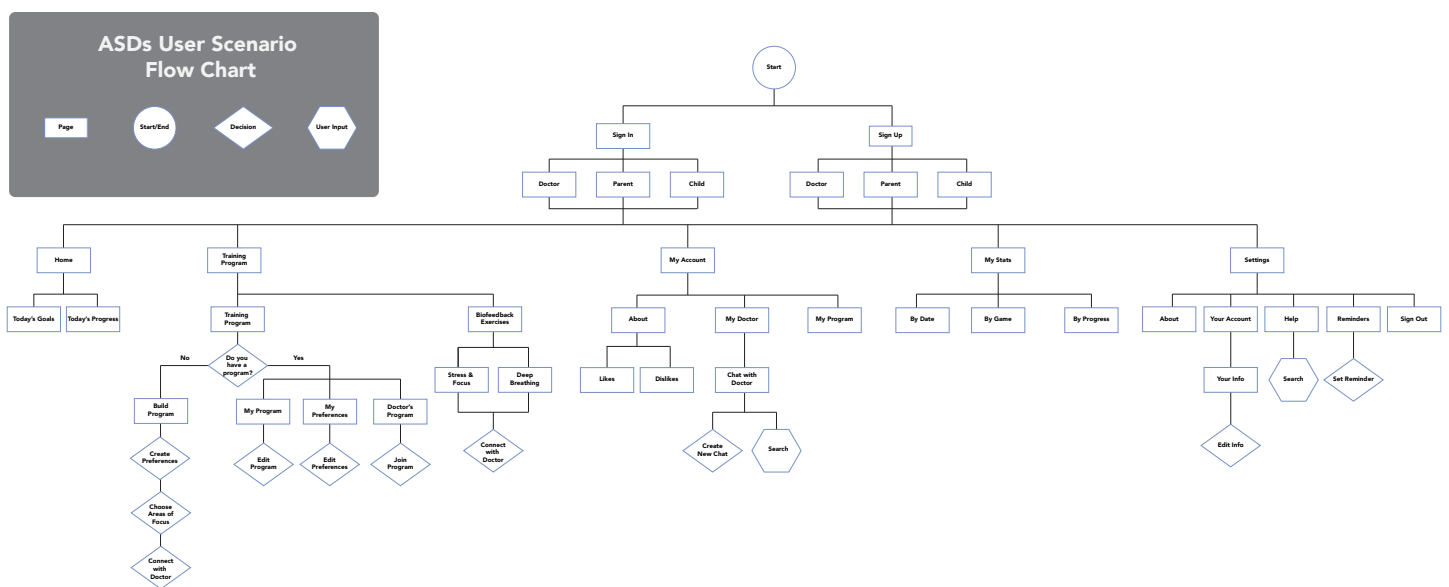
Users are willing to compare behavioral areas they can develop, and participate in biofeedback exercises that are clear, engaging, and targeted for that user's ASDs level.

Users are expecting an experience that encourages and demonstrates development and they will recommend to others.

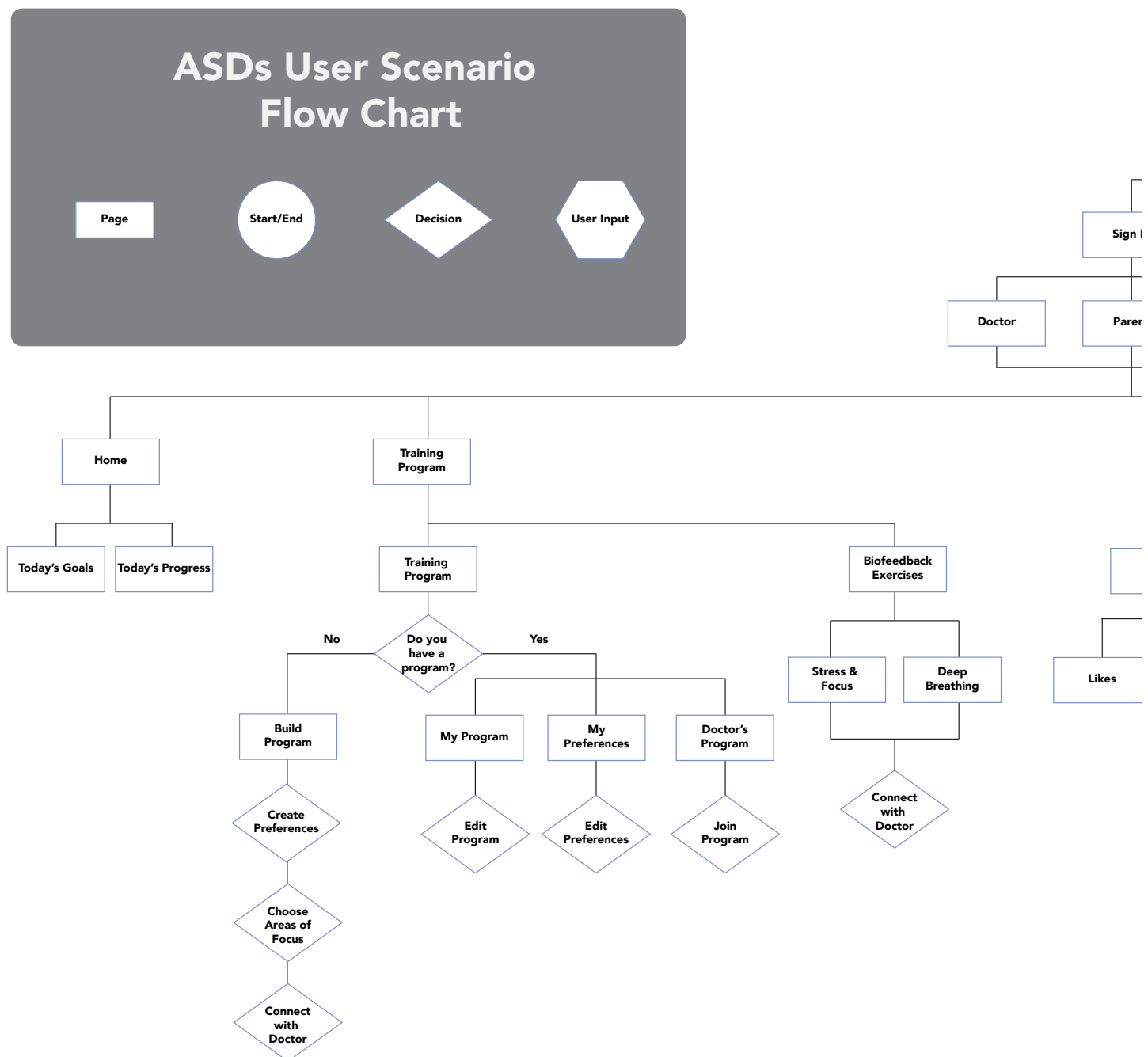
Users are willing to share their progress with their doctors, to look over and keep track of brain development



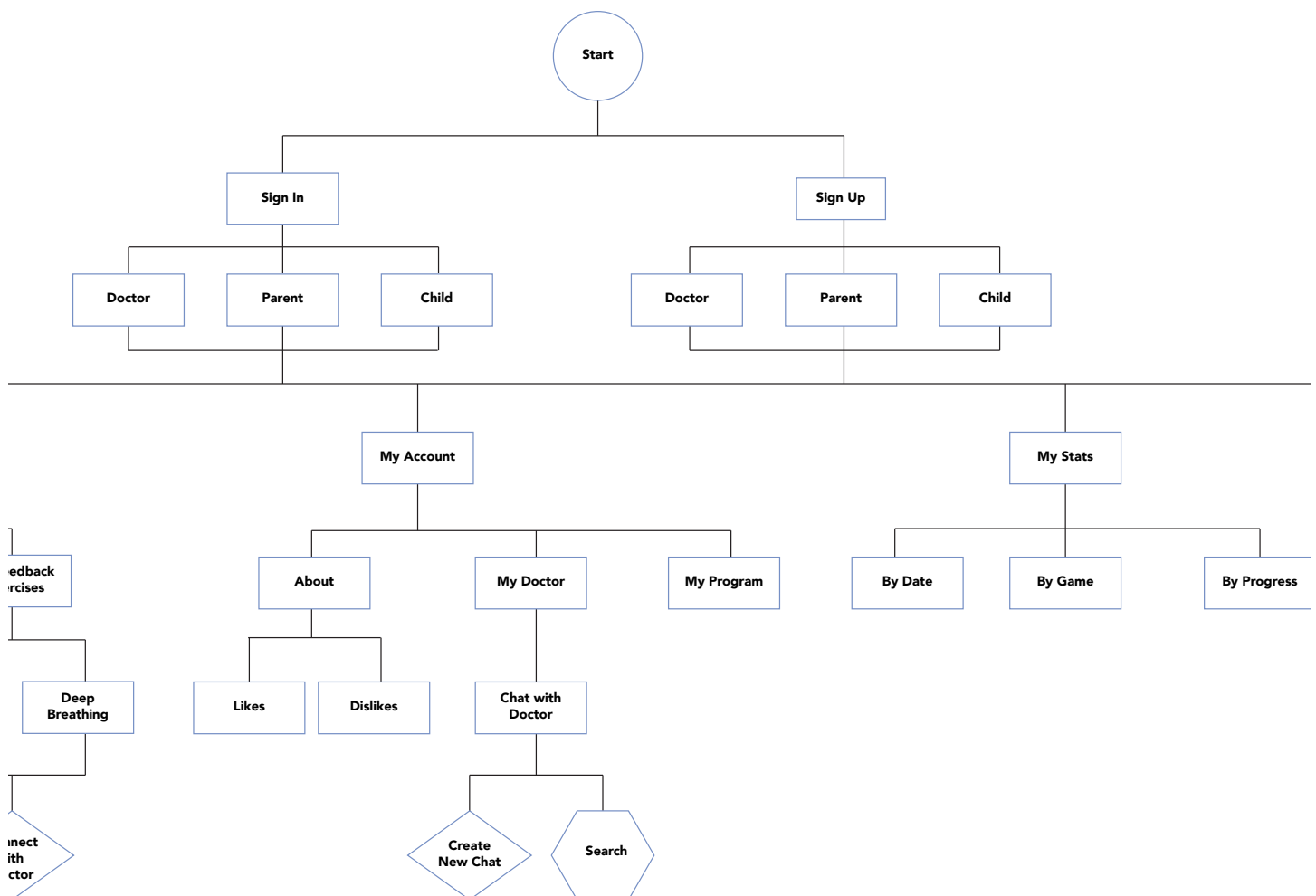
# User Flow Chart



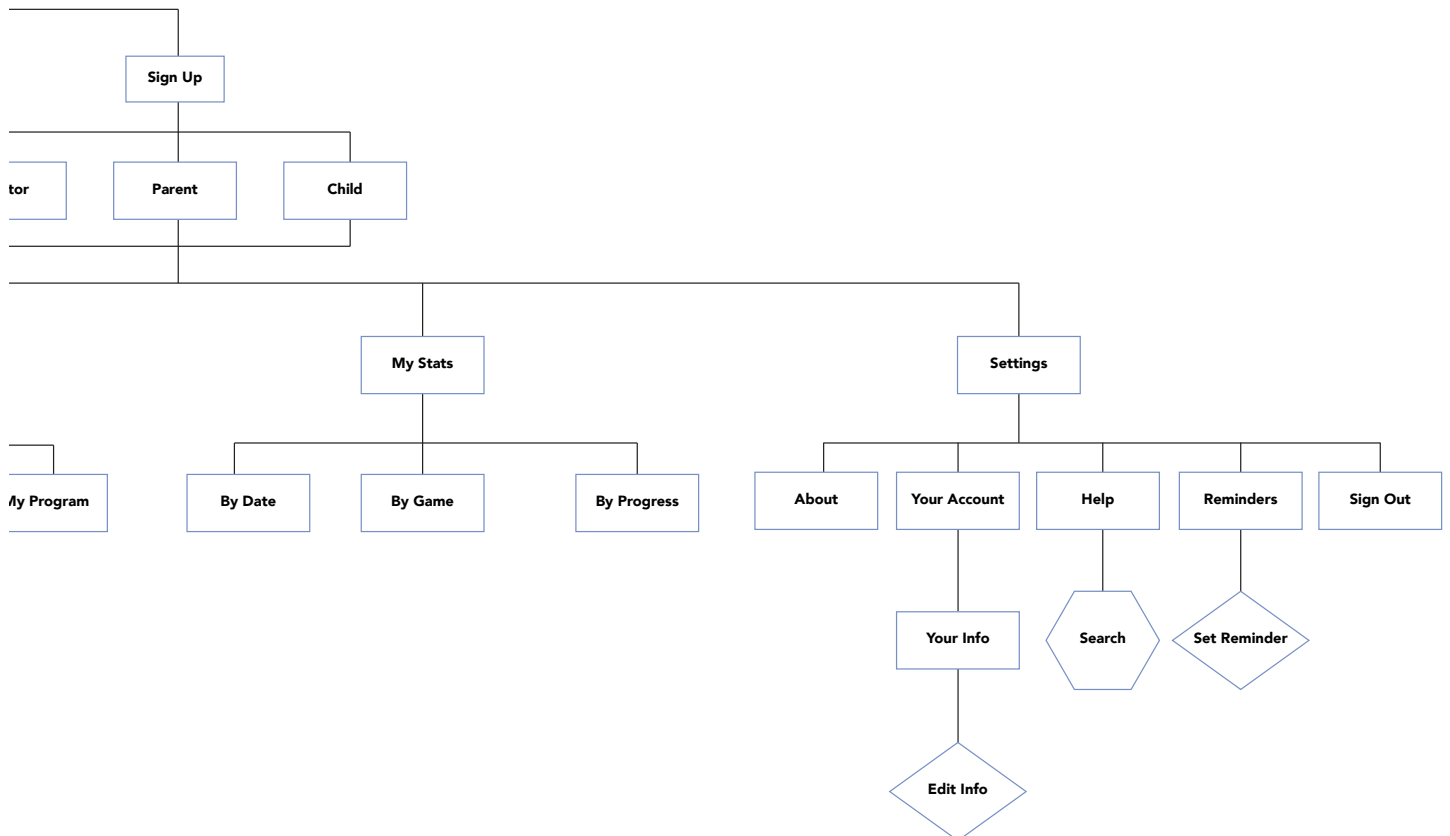
## User Flow Chart Close-Up 1 of 3



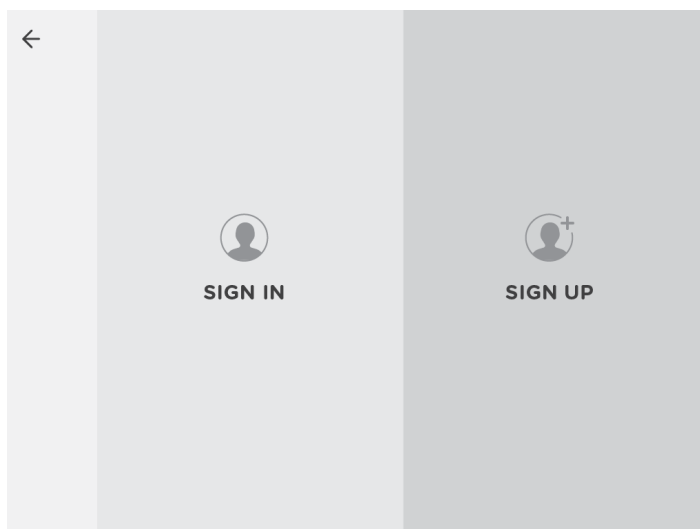
## User Flow Chart Close-Up 2 of 3



## User Flow Chart Close-Up 3 of 3



## Wireframes



## Wireframes

A wireframe of a mobile app sign-in screen. The screen has a light gray background with a darker gray header and footer. The header contains a back arrow on the left, the text "SIGN IN" in the center, and a user profile icon on the right. The main content area features a form with two input fields: "Username" and "Password". The "Password" field is split into two parts, with the second part containing the text "Forgot". Below the form is a large, rounded rectangular button labeled "LOG IN". At the bottom of the screen, there is a link that reads "Terms of use. Privacy Policy".

A wireframe of a mobile app sign-in screen, similar to the one above but with sample data. The header and footer are identical. The form fields now contain "ear7370" in the "Username" field and "\*\*\*\*\*" in the "Password" field. The "Forgot" link is still present. The "LOG IN" button is also present. The "Terms of use. Privacy Policy" link is at the bottom.



## Wireframes

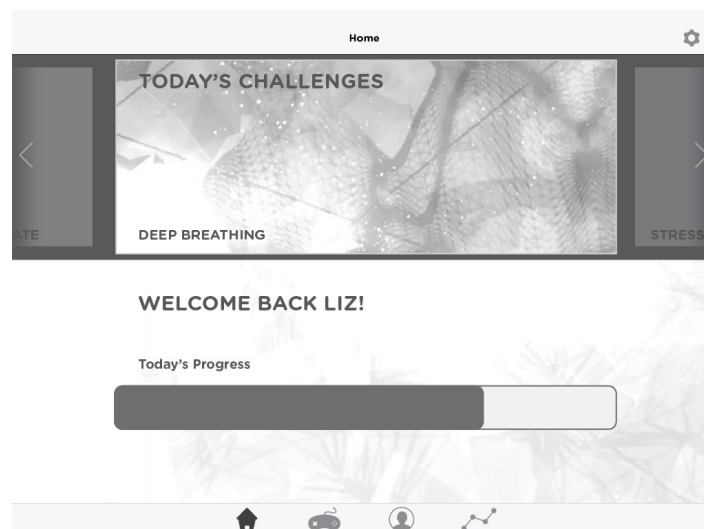
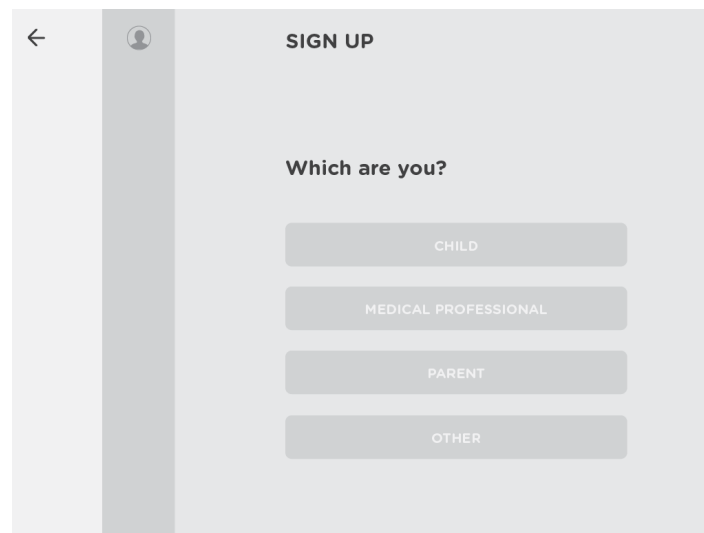
This wireframe shows a mobile app sign-up screen. It features a left sidebar with a back arrow and a user profile icon. The main content area is titled "SIGN UP" and contains the following elements:

- A "Username" input field.
- A "Password" input field.
- A "Confirm Password" input field and a "Forgot" link.
- A checkbox labeled "I have read and accept Synapse's Terms of Use".
- A "SIGN UP" button.
- A link: "Already have an account? Sign In".

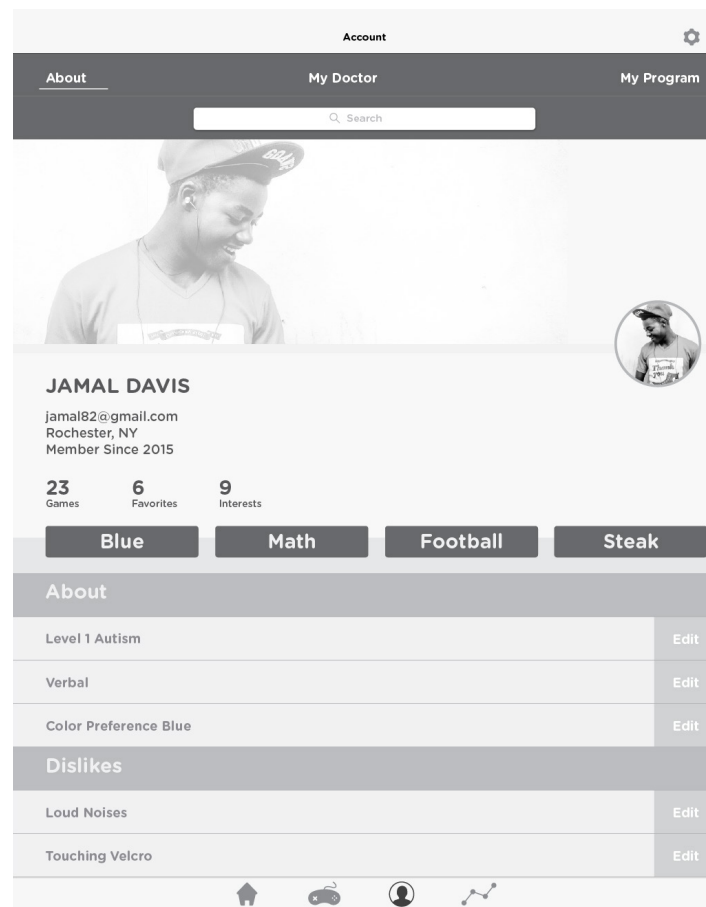
This wireframe shows the same mobile app sign-up screen as above, but with sample data entered into the input fields:

- The "Username" field contains the text "ear7370".
- The "Password" field contains seven dots.
- The "Confirm Password" field contains seven dots.
- The "I have read and accept Synapse's Terms of Use" checkbox is checked.
- The "SIGN UP" button is highlighted in a darker gray.
- The "Already have an account? Sign In" link remains at the bottom.

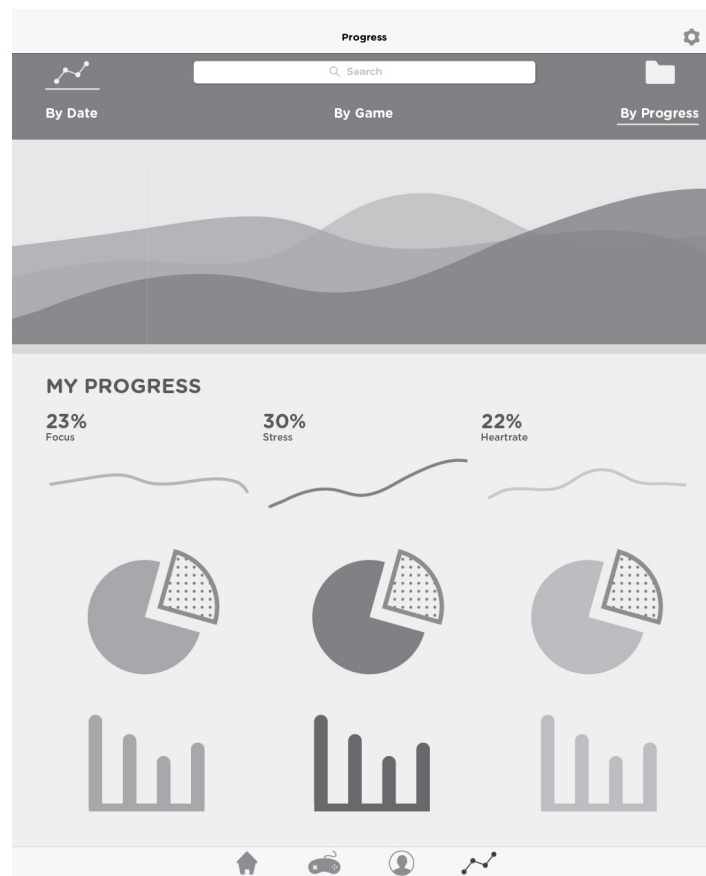
## Wireframes



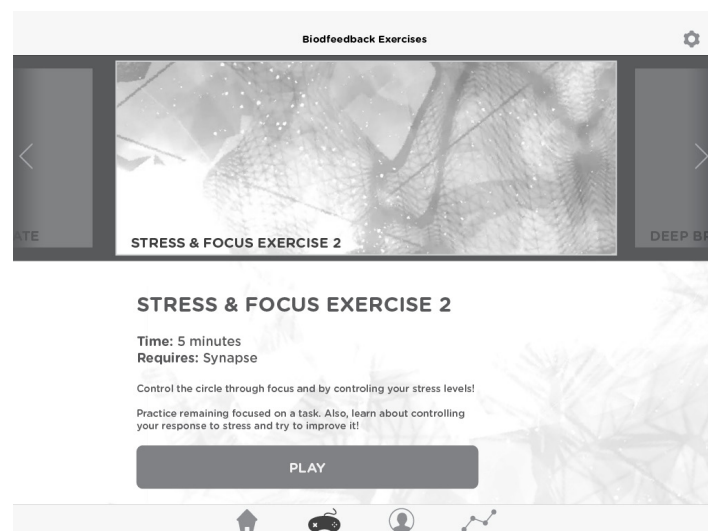
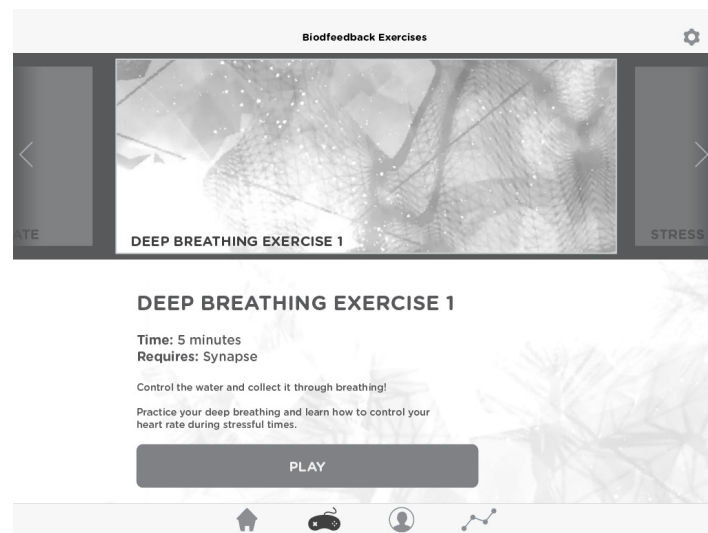
## Wireframes



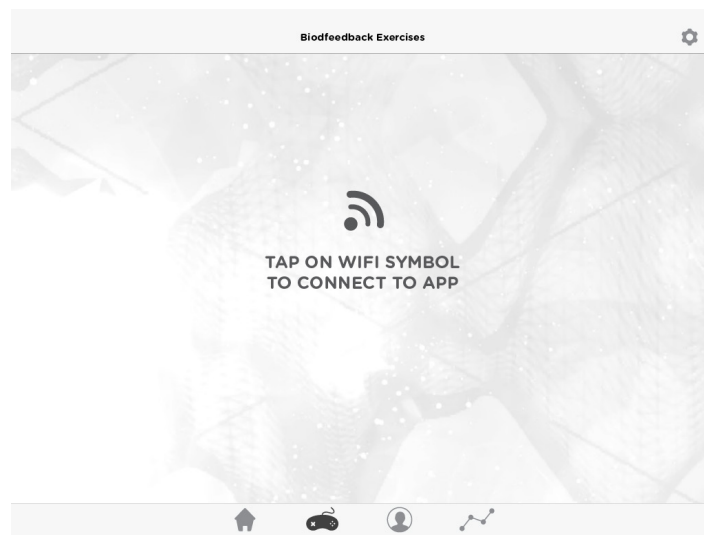
## Wireframes



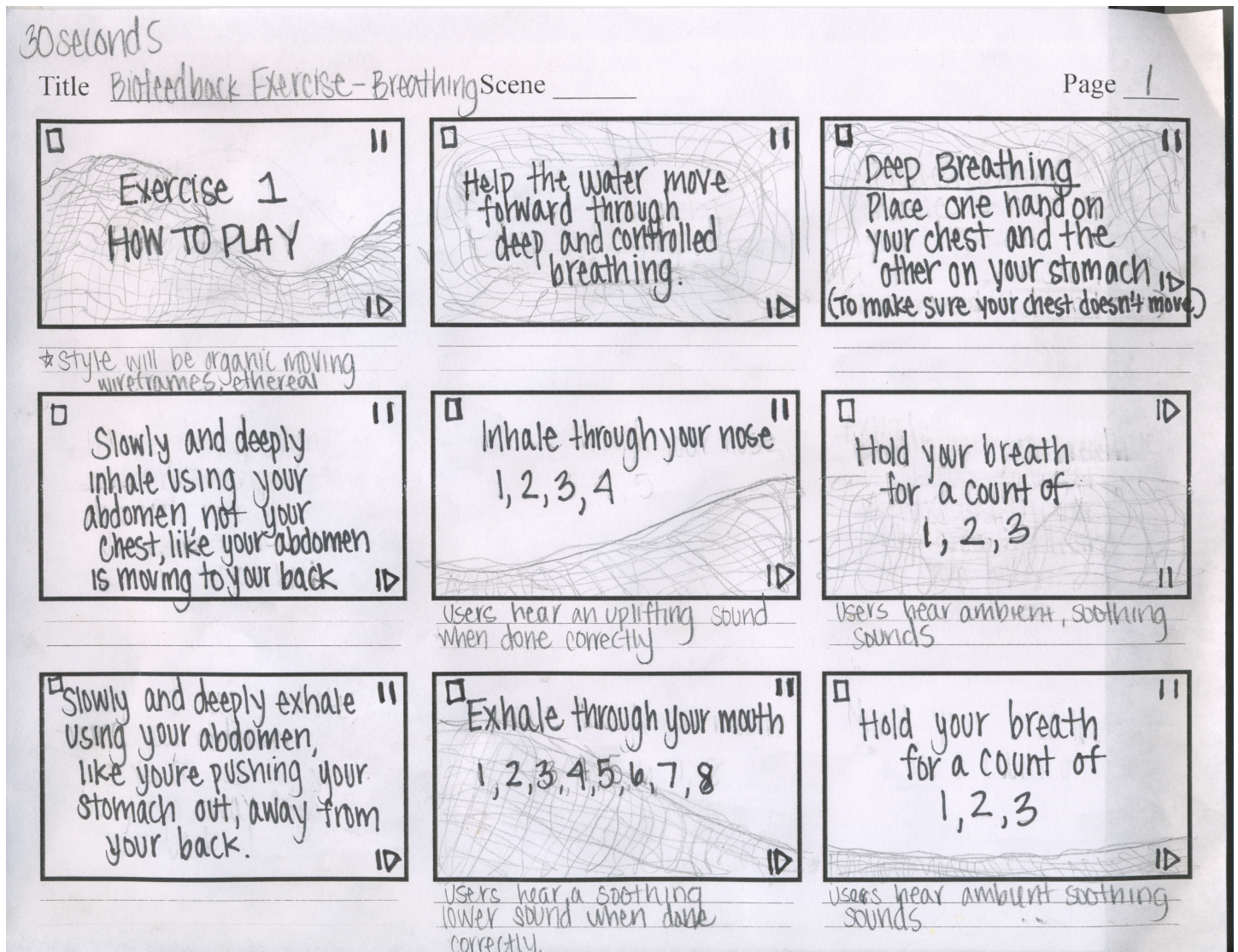
## Wireframes



## Wireframes

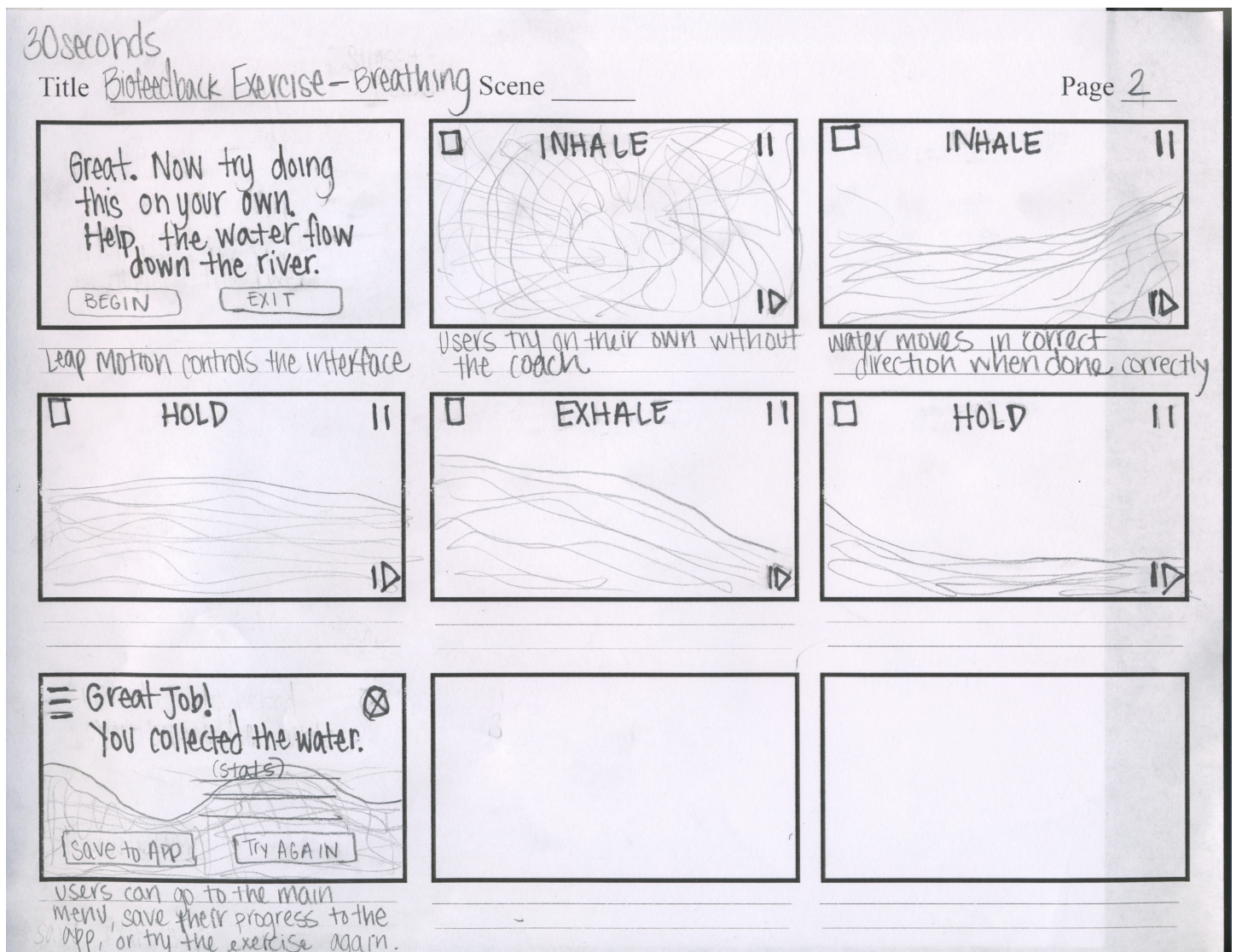


## Storyboard 1



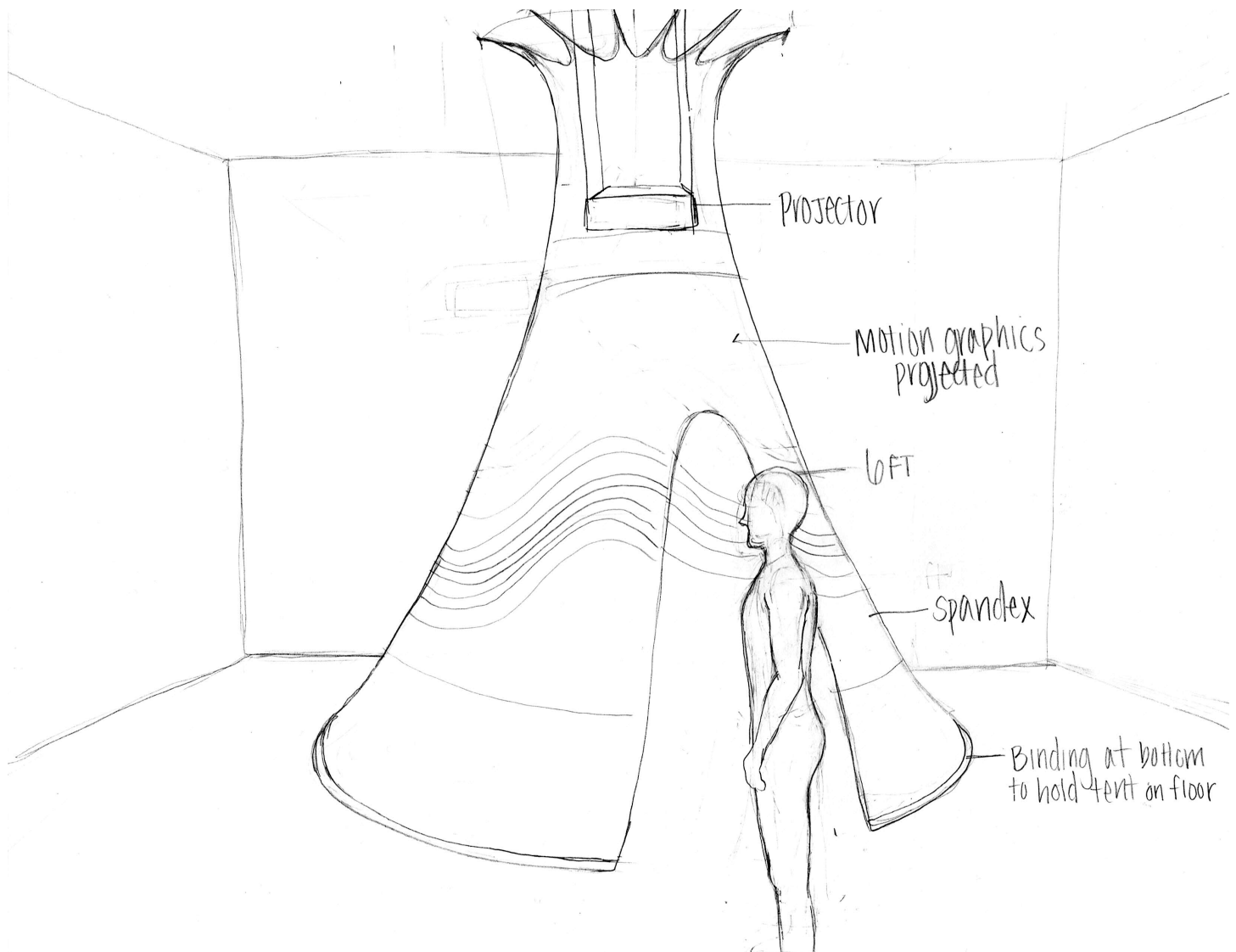


## Storyboard 1





## Conical Tent Design



## Methodology

### Design Inquiry

Can a mobile application and an immersive biofeedback exercises be an effective means for people with ASDs to receive biofeedback therapy? Can we implement this strategy to sensory rooms by projecting biofeedback information in an exercise format and having users interact with it? Can designers more efficiently and effectively communicate medical jargon in a thoughtful and clear way for families, medical staff, and people with ASDs?

### Target Audience

This thesis project will be centered on people with autism ages six to twenty years old. However, the application will be prototyped for a sixteen-year-old child with an autism social communication level of 1 or 2 who is verbal.

The value that this project is that it will unify the disconnect between medical professionals, people with ASDs, families, and treatment facilities, by creating an application where all of these separated groups can work together in a proactive approach toward health. This proposal will be a preventative measure to possibly help with health care and make it less reactive to problems that arise. This proposal could be utilized in sensory rooms at a user's home, or in a facility. It could also be implemented in hospitals since so many ERs across the nation are receiving incoming patients who have These ERs are having to develop separate areas for their ASDs patients. This proposal could be implemented within a private area of an ER for patients with ASDs. Additionally, this proposal brings to families and children with autism new forms of access to treatment technology that is proven to help children with ASDs with communication, behavior, and social interactions.

## Project Deliverables

### Concept

This proposal seeks to design and build a ten-foot tent, conical-shaped structure in which a one-minute motion graphics piece will be projected inside of. Users will be able to walk into the conical structure and view a biofeedback exercise in-session. This concept provides new interactive technology for ASDs treatment.

The second part of this proposal seeks to design a hi-fidelity mobile application, non-working prototype, that corresponds with the motion graphics experience. Theoretically, this mobile application will connect to the conical structure, and allow users to save their progress. The mobile application will feature a toolbar that includes access to: a home screen featuring a user's overview of exercises to complete that day depending on the user's training program, a biofeedback exercise page where users can build a training program with their doctors, a user's account page, and a user's stats page where they can review their progress according to date, game, or progress. Additionally, within these pages, users can view measured growth, receive tips to improve, view a training plan and edit preferences within the plan according to the users likes and dislikes, play biofeedback exercises, understand the science behind the app, and get help about how to use the app.

### Software will potentially include:

Adobe Illustrator, Photoshop, After Effects, Biofeedback technology, Processing, Sketch, Garage Band, Resolume Arena 5, Red Giant Trapcode and Cinema 4D. These programs will be used to create: the application's user interface, the user experience, wireframes, layouts, motion graphics for the exercise, and an interactive hi-fidelity and lo-fidelity non-working application.

### Scope of Project

The app serves people ages 6 to 20 years old with ASDs. However, the hi fidelity app and motion graphics piece will function for a child with an ASDs social communication level of 1 or 2, who is also verbal. The biofeedback exercise will be centered on deep breathing.

**Motion & Interaction**

The motion graphics piece will represent the visuals and interface of the interactive exercise. The biofeedback exercise will be centered on deep breathing. The motion graphics piece will represent how the user interacts with the interface and its use of a positive reward system. The motion graphics piece will show that when users breathe correctly, they receive a reward through auditory and visual feedback.

The breathing exercise will feature a shape similar to a sine wave, the ideal shape of breathing patterns. Users will need to properly get the wave to move forward, similar to that of flowing water, while also maintaining its shape. The user's goal is to move the water forward so that it can be collected. Visual and auditory feedback will be utilized as a positive reinforcement system. As users correctly breathe, the sine wave will move calmly forward and form the shape of a blue-in color, smooth wave.

The biofeedback environment does not require that the user touch or contact the interface. The mobile application works in conjunction with the biofeedback environment. The user initiates the biofeedback exercise through the mobile application.

**Details of Project****App and Motion Graphics Dimensions**

iPad 2 - 1024 pixels x 768 pixels

Motion graphics - 1920 pixels x 1080 pixels

Design	Technology	Subject Matter
UI/UX Design	Resolume, Projector	Interactive Feedback Games, Color Theory
Interaction Design	Adobe: Illustrator Photoshop Sketch Invision	Interactive Feedback Games, App User Interface
Motion Graphics	Adobe: Illustrator Photoshop Cinema 4D	Interactive Feedback Games

## Implementation Strategies

This thesis project will be carried out through thoughtful planning, the investigation of the most effective methods to create a helpful and easy to use app for children with ASDs.

The biofeedback exercise will focus on breathing

### **RIT Center for Applied Psychophysiological Sciences**

I plan to work with CAPS to better understand symptoms of autism and effects it has on children. In the case of problems or questions arising, CAPS will serve as an excellent resource to re-focus the thesis project.

### **For Research**

Research articles, papers, journals, theses, current technology, and websites.

Interview professionals who are experts on ASDs.

Collect information through interviews and surveys.

Analyze past case studies and emerging technologies used with ASDs.

Based on findings identify

- Ways to digitally identify levels of autism
- Ways to engage children with ASDs and motivate to use app
- Means of re-focusing a child with ASDs
- Layout and framework that is stimulating and engaging for ASDs
- Ways of visually representing biofeedback
- Visual representation of biofeedback in game-mode
- Collect real-time usability feedback from students.
- Collect comparative analyses.

### **For Mobile App Framework**

- User Research Process Flowchart
- Information Architecture
- Lo-Fi Wireframes
- Hi-Fi Screens

### **For Projected Motion Graphics In Conical Tent**

Previous knowledge of Resolume Arena 5 and a class in projection mapping will

greatly help the implementation of the projected motion graphics.

- Storyboard
- After Effects motion graphics
- Imported After Effects motion graphic into Resolume Arena 5
- Project motion graphics onto conical tent

## Dissemination

The dissemination of this project transcends the thesis timeline since it will occur once the working prototype is completed and tested.

The plan to promote the final outcome will start by presenting the prototype to the Center for Applied Psychophysiological Sciences at Rochester Institute of Technology. I plan to also show my prototype to the AI SigI Center in Rochester, New York. Both of these organizations could potentially make use of and develop this application.

The next step will include submission to the following design competitions:

- ADDA - Adobe Design Achievement Awards
- IxDA Student Design Challenge
- HOW International Design Awards
- Communication Arts Interactive Design Annual
- Core77 Design Awards



# Evaluation Plan

## Methods

Peer Reviews  
Usability Evaluation  
Outcome Evaluation  
Impact Evaluation

## Focus

Clarity  
Impact on existing practices  
Ease of use  
Overall Experience

## Success Criteria

- Easy to incorporate suggestions without changes to existing methodology
- User is able to understand and implement biofeedback exercise with ease
- User is able to easily navigate the app

The evaluation plan will consist of a series of evaluations with feedback done with peers within and outside of the design field. In addition, two rounds of prototype testing will be done for the app portion of this proposal. This testing will focus on usability, communication, and ease of navigation. A series of evaluations and feedback will be done for tent motion graphics.

The first round of app testing will be done with a paper prototype in order to ensure the application is clear and logical through its layout and button placement. Additionally, this round of testing will collect suggestions for improvements on the applications ease of use and communication.

The second round of app testing will be done with high fidelity screens. This will test the effectiveness of the application's communication for children with autism. This test will also explore the effectiveness of the biofeedback exercise, to user, to game structure as well as aesthetics. This round will be done with a professional in the field of autism. Users will be asked un-biased questions focused on the application's successes and how it can be improved to better serve children with autism.

Imagine RIT is a creativity and innovation festival that takes place on May 2nd at Rochester Institute of Technology. Imagine RIT will serve as an opportunity to test the app with a diverse audience. Although the event attracts many people, their profile type may not necessarily be favorable toward usability testing because many of them most likely will not have autism. Despite this, Imagine RIT provides an opportunity to test the product's effectiveness of communication and get feedback on the visual design. The plan consists of setting up the conical structure to the projector and computer to allow visitors to explore the motion graphics experience. Upon completion, visitors will be given an explanation of the application and asked to complete a 5-minute digital survey through Google Forms.

## Pragmatic Considerations

I have a timeline carefully planned.

### **Budget**

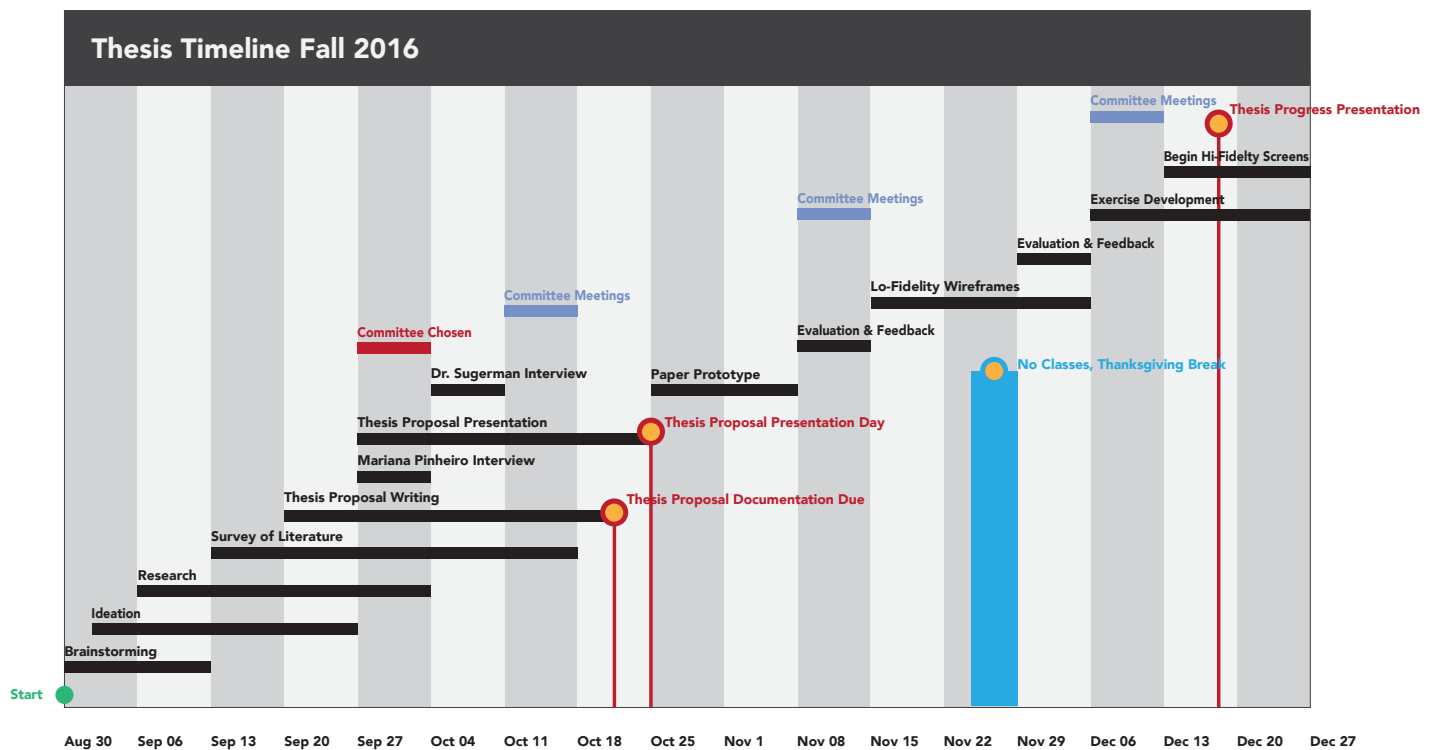
Tent spandex material	\$100
Plastic molding for tent base	\$30
Used Projector	\$30
RIT Macbook with Resolume	Free - Borrowed

### **Dissemination**

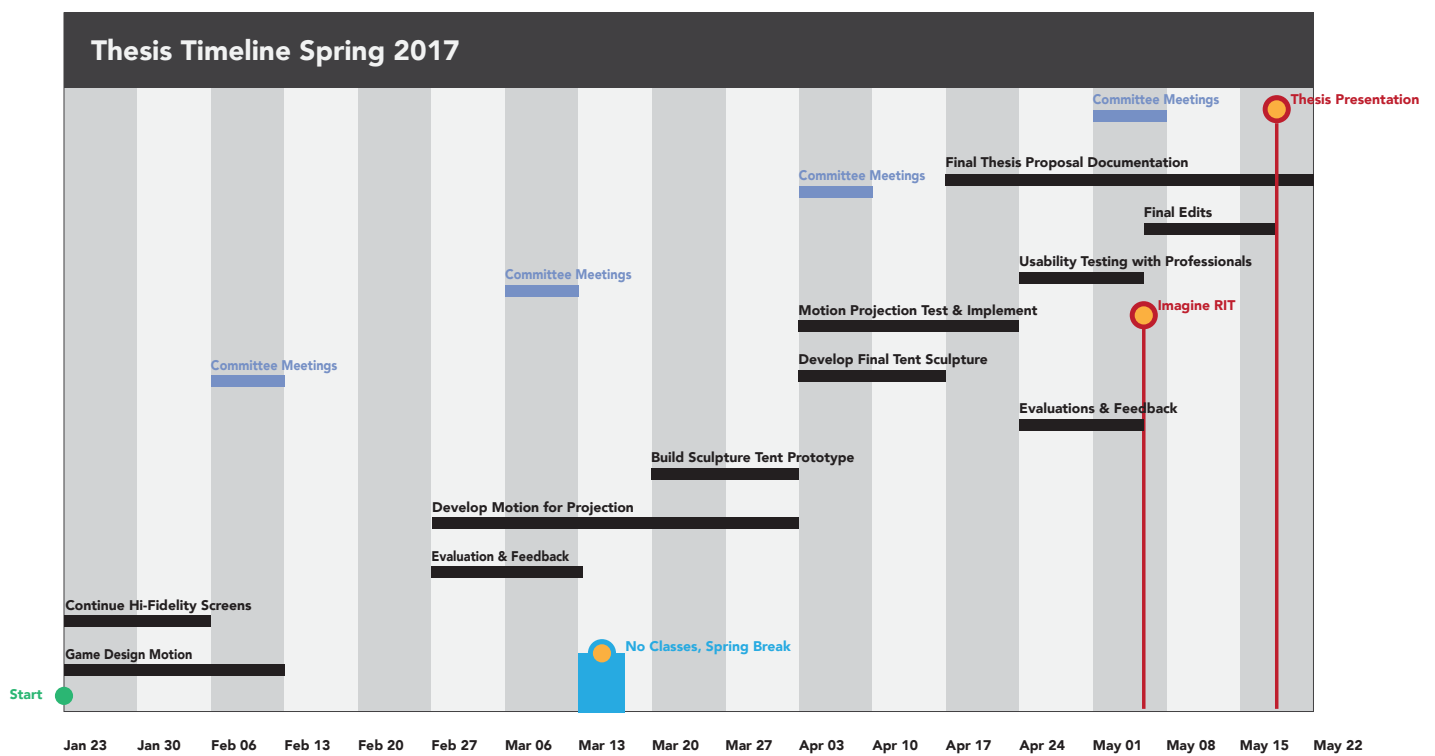
Submissions	\$200
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\*Expenses are subject to change and based on an estimation of what I expect to spend throughout my thesis.

## Timeline Fall 2016



## Timeline Spring 2017



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